The Laser User

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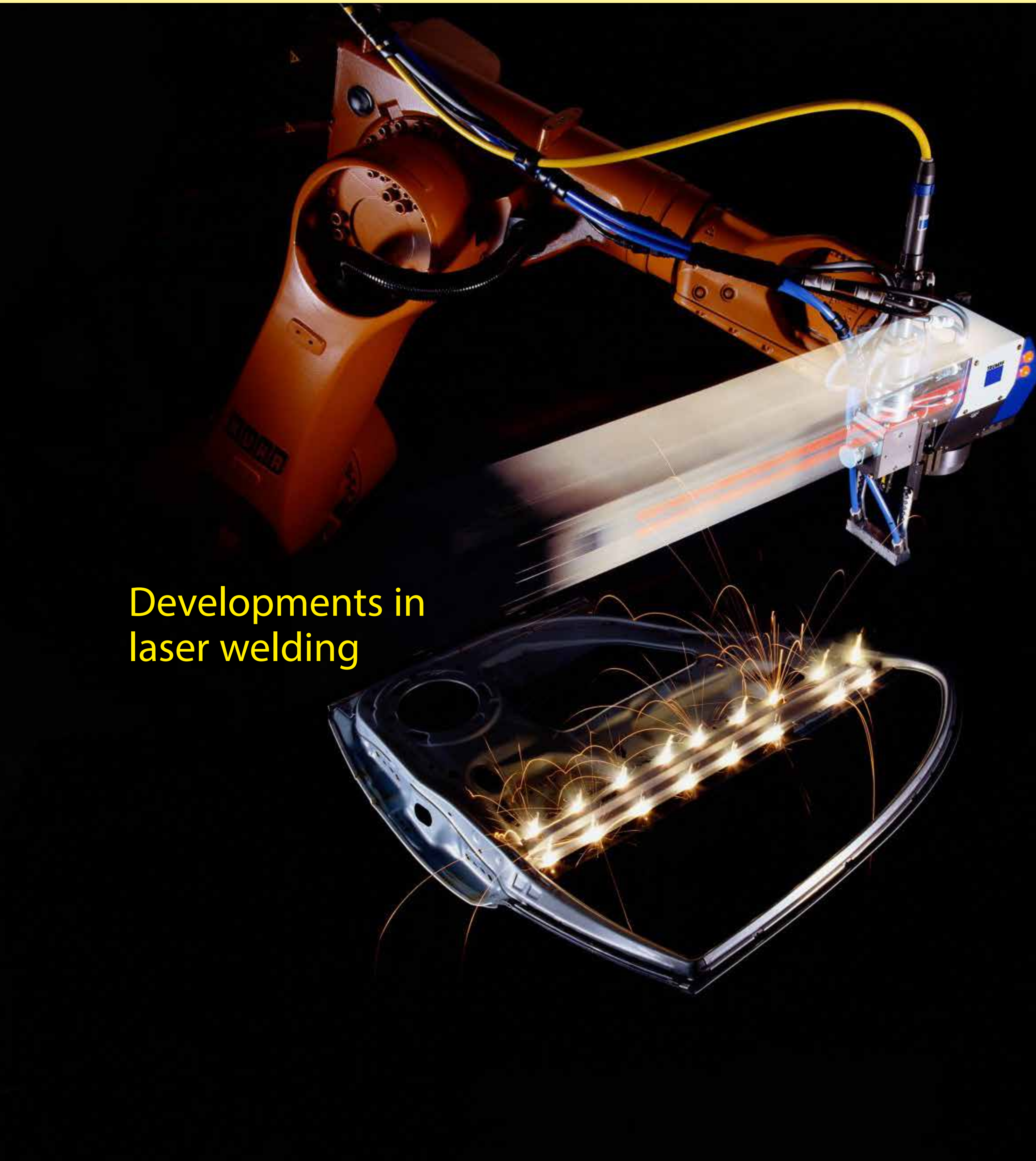
Autumn 2008



Developments in laser welding

The AILU objectives

The principal objectives of AILU include:

- To foster co-operation and collaboration on non-competitive technical matters and provide a forum and mechanisms for sharing experience and expertise.
- To encourage the expansion of laser use into applications where they can add value and increase company competitiveness.
- To represent and promote the interests of industrial laser users.
- To disseminate professional and other information to members.
- To promote best practice in the commercial applications of lasers in materials processing and allied technologies.
- To support the maintenance and improvement of standards of laser safety and performance.

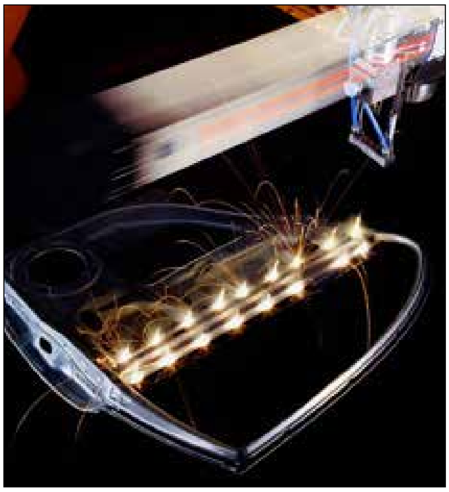
AILU membership is a valuable source of information concerning laser technology and applications. Benefits include:

Benefits of membership

- Subscription to The Laser User, the leading magazine on laser applications with news and views from the UK and world-wide.
- A 'hot-line' consultancy service provided by members for members.
- Free entries in the AILU Product and Services Directory on the web site.
- Regular meetings, including members-only meetings and open workshops e.g. where key areas of technology are open for discussion.
- Access to the members' area of the web site with lots of technical articles plus frequently asked questions, current laser safety and performance standards etc.
- Major discounts on registration fees for events organised by AILU and affiliated bodies.

the association of AILU laser users

Helping you make the most of laser technology



Courtesy Trumpf

The cover photo, which illustrates the remote welding of a car door, is taken from Thomas Schwoerer's paper on remote laser welding on page 46. Other welding features in this issue include a paper on page 36 by Dirk Petring on hybrid welding and combinaton cutting and welding; a comparison of fibre laser and lamp-pumped Nd:YAG laser welding by Mo Naeem and Steffan Lewis on page 40; and the welding of closed box structures by Christian Walz et. al on page 43

MEMBERS' NEWS

Association

UK in laser materials processing R&D capability and the way forward

With the support of the Photonics KTN AILU has conducted a survey to identify the lead players in the research and development (R&D) of laser materials processing in the UK. The work involved making contact with hundreds of companies and universities, initially by email and followed up by over 100 interviews and/or visits. The work was carried out during the summer of 2008 by founder committee members John Powell and Bill Steen. John undertook the survey of industries and Bill the academic survey.

Commercial organisations were rated according to their level of activity and expertise in laser materials processing (LMP) and divided into two groups. The report contains an 'A' list of the most active and advanced commercial players and a 'B' list of firms that might be persuaded to get involved in future R&D projects. Similarly, the academic survey identified those with a considerable and serious commitment and those with a peripheral interest,

The report is available to AILU members in draft form in the resource library of the members' area of the AILU web site.

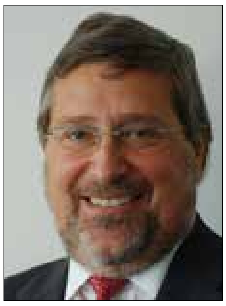
The second step of the project is a 1 day workshop titled 'Future Developments of Laser Materials Processing in the UK', which is being held at Warwick University on 2 October. The top level academic and commercial research organisations identified in the report have been invited.

The workshop objective is to generate a list of ideas (or needs) for future research and development in the field of LMP. This of course needs to be established together with some indication of the likely impact it would generate (ie the broader economic, green or sustainability benefits that might result from the research work). The results of the workshop will be made available on the AILU web site and the forum of the newly formed AILU Product and Process Innovation (PPI) Special Interest Group will be made accessible to all participants and AILU members involved in research activities.

A report of the workshop and the results of the survey will be presented to the Technology Strategy Board and we hope that the exposure these two complementary documents receive will help support appropriate future R&D activities.

People

Eckhard Beyer wins 2008 Arthur L. Schawlow Award



Dr. Eckhard Beyer, Professor at the University of Technology Dresden and Executive Director of the Fraunhofer Institute for Material and Beam Technology IWS in Germany was recently awarded the highly distinguished 2008 Schawlow Award for his contributions to laser science and engineering.

Eckhard's accomplishments include the development of a rotating hollow needle for beam diagnostics, which is still in production world-wide. In the late 1980s, he achieved important patents in process control during laser cutting and welding. He is a recognized authority in laser hybrid welding, laser coating and novel laser beam techniques.

A regular contributor to this magazine and AILU workshops, his leadership of the Fraunhofer IWS has helped establish the organization as a world class centre for laser surface engineering, coatings, and laser materials processing.

OBITUARY

Julian Coutts

Dr Julian Coutts died on Tuesday 1st July in Edinburgh, the city of his birth. For some months he had been diagnosed as suffering from an inoperable cancer of the liver.

Julian joined Colin Webb's laser group at Oxford University in 1983 and is well known in laser circles for his work on 'halogen donor instability', it provided an explanation of the pulse length limiting mechanisms of excimer laser plasmas, which has been successfully tested experimentally in laboratories around the world.

Julian worked at the Joint Institute for Laboratory Astrophysics in Boulder Colorado USA and at the BP research laboratories in the UK, but when BP closed down its in-house research effort he took an MBA and moved into financial services.

Our condolences go to Julian's wife Jenny, and their two daughters Zoe and Imogen on the untimely death of such a talented scientist.

Colin Webb

New laser research group established

Martin Sharp and Paul French have joined the General Engineering Research Institute (GERI) at Liverpool John Moores University and are in the process of setting up a "Photonics In Engineering" research group that will initially concentrate on laser materials processing. Martin and Paul, formerly of the Lairdside Laser Engineering Centre, University of Liverpool, will initially concentrate their efforts in micromachining, especially in the biotechnology and aerospace sectors.

Martin Sharp (left) and Paul French in their new home

"Paul and I remain committed to working with industry and to developing relevant knowledge exchange activities, and the move will allow us to do this in a more academic context," said Martin.

Paul added that the time spent at Lairdside had allowed him and Martin to work with industry and that this would provide the motivation behind the majority of their research efforts.

The GERI institute, based within the faculty of Technology and Environment at Liverpool John Moores University (http://www.ljmu.ac.uk/geri/), is active in a variety of fields including optical metrology, advanced manufacturing technology, radio-frequency & microwave research to electronics, image processing and mechanical engineering. It currently has between 40 and 50 full and part time members. Professor David Burton, Director of the Institute, says that "establishing the Photonics in Engineering research group is a key development for GERI and I look forward to working with Martin and Paul as they develop their research portfolio."

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Laserdyne's new European Sales Manager

Prima North America have appointed Paolo Busti to the position of European Sales Manager for Laserdyne Systems.

In announcing the appointment, Terry VanderWert, President of Prima North America, stated that Mr. Busti will manage all of Laserdyne Systems sales activities throughout western and eastern Europe and will be based at the Prima Industrie corporate offices in Torino, Italy.

Mr. Busti's career includes a number of positions for Avio S.p.A., a world leader in aerospace propulsion technology development and manufacture. Most recently, he was program director for Avio's Aero Business Unit. Earlier in his career, Mr. Busti held positions in control system design for automation systems.

Mr. Busti is a graduate of Politecnico di Torino with a degree in electronics engineering and is a licensed engineer in Italy. He also holds a Six Sigma Black Belt.

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New team member at Purex

Miguel Ramírez joins Purex with fifteen years experience in sales and marketing.

He has worked for a major German defence company during this time in various sales and management positions. Miguel has joined Purex as a European Distributor Manager alongside John Twigg. From Miguel, "Purex have made themselves well known globally over the years as one of the best fume extraction companies in the market. I am looking forward to being a part of this success and to contribute with my experience to Purex customers."

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Initiatives

GSI to spearhead £1.2m "world class" research project

GSI Group's laser division at Rugby is to launch a £1.2m collaborative research and development project in partnership with the LPA Group at Heriot-Watt University, PowerPhotonic Ltd. and Cranfield University, thanks to investment from the Technology Strategy Board.

As lead partner in the High Efficiency Laser Processing Systems (HELPSYS) Project, GSI is aiming to develop fibre coupled diode laser sources with beam qualities good enough for a broad range of mainstream applications. Specifically this will include a significant increase in the efficiency of current laser based welding processes to the point where they are more efficient than even conventional MIG or other techniques.

The technology developed by the HELPSYS project will be particularly relevant to high power applications in intensive production environments where ultimate process efficacy and total efficiency are important – such as automotive production, which requires significant quantities of high quality welds in large volumes.

Mark Greenwood, GSI technical director, said: "to date, diode system beam quality has limited their market to niche applications such as soldering, plastic welding, hardening and cladding. The significant beam quality improvements proposed by this project would enable diode laser systems to enter many of the markets dominated by high power CO_2 and lamp-pumped Nd:YAG lasers."

He added: "We are confident that this project will directly benefit the laser and industrial processing industry, by developing new technologies for high power diode lasers and their use in new high efficiency welding processes, increasing the overall efficiency and achieving challenging cost and volume manufacturing goals."

Commenting on the Technology Strategy Board's investment in the project, their Technologist for Electronics, Photonics and Electrical Systems, Mike Biddle, said: "The advanced laser processing system that will be developed through this project has the potential to be exploited globally. We are pleased to invest in this world class research and development."

The project incorporates plans for base modules which will integrate new capabilities at the diode laser chip level, innovative mounting and cooling configurations including new multi-layer planar ceramic technology, utilisation of new beam correction technology, and novel multi-beam to optical fibre coupling techniques.

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£8M grant for next generation lasers

The University of Dundee and 18 European partners have been granted around £8M to develop a new generation of biomedical lasers. The lasers will be much smaller and more efficient than current lasers and will be designed for high precision cutting, imaging and treatment therapies.

Five new research posts will be created in Dundee with the money and nearly 100 man years of effort will be directed towards the world class research throughout the partnership.

Prof Edik Rafailov, of the University of Dundee, said: 'This project will revolutionise the use of lasers in the biomedical field, providing both practitioners and researchers with pocket-sized ultra high performance lasers at a substantially lower cost, which will make their widespread use affordable.'

Business

Trumpf intend to purchase SPI Lasers

Trumpf and SPI Lasers are pleased to announce that Trumpf intends to make an offer to buy the entire share capital of SPI Lasers. The combination of SPI Lasers' products, world-class fibre laser technology, engineering and manufacturing along with Trumpf's complementary technology, operational excellence and resources will enable Trumpf to quickly establish a leading position in the rapidly growing fibre laser sector.

Trumpf expects that SPI will be a centre of fibre laser excellence within the Trumpf group, operating from the existing facilities in Southampton UK.

Commenting on today's announcement, Peter Leibinger, Vice-Chairman of the Managing Board and Head of the Laser Technology and Electronics Division, said: "I firmly believe that both SPI Lasers and Trumpf will benefit from this proposed transaction. While the overall market for industrial lasers is expected to grow further in the future, particular growth is expected in the lower power range, an area in which SPI Lasers' products have already established a strong market presence. A broad product portfolio of SPI Lasers in the fibre laser segment would complement Trumpf's existing product and technology platforms and create a stronger combined industrial laser offering."

Dr David Parker, Chief Executive Officer of SPI Lasers added "We are delighted by this announcement. Whilst we are proud of our achievements to date there is no doubt that with the support of the Trumpf organisation we can take the business to a higher level and be a major player in this exciting sector. We see many opportunities to leverage our world class technology position into new products and markets and look forward to working within the Trumpf group to achieve this".

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Domino enters solid state laser market with acquisition of Photon Energy

Domino Printing Sciences has acquired solid state laser marking specialist Photon Energy GmbH and its subsidiary, NWL Lasertechnologie GmbH, for a price of €4 M.

Based in Ottensoos, Germany, both companies are active in the field of solid-state laser marking technologies, i.e. Nd:YAG, Vanadate & Fibre lasers, which are used in plastic and metal parts marking and surface decoration applications.

As a pioneer of easy-to-use laser marking systems, Photon Energy and NWL bring almost 20 years of industrial experience to Domino, where they will continue to be led by Dr. Hans Amler, currently General Manager of both companies.

The Photon Energy product range incorporates leading edge laser source technology for solid-state lasers, operating at a wavelength of 1064nm and harmonics (e.g. 532nm). Maximum flexibility for the end user or integrator is afforded by a choice of power variants and options to specify compact stand-alone lasers or complete systems in standard industrial housings. Photon Energy products are used widely in the manufacturing sector, with an installed base incorporating leading names such as Siemens, MTU Aircraft Engines, General Motors and BMW.

One of many Domino products: the DD3 Dot Matrix printer

Nigel Bond, Domino's Group Managing Director, said, "We have made this acquisition to address the growing demand from our customer base for solid state laser systems and to expand Domino's reach into the automotive, aircraft, electronic, tool and medical sectors currently served by the Photon Group.

"The acquisition is a logical extension of our existing CO_2 laser business which serves the coding and marking requirements of the food, beverage, pharmaceutical and tobacco sectors," Nifel added.

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Photonics KTN stimulates training and research opportunities

Training facility

The Photonics KTN Training Portal was launched at the beginning of August 2008 and is now available for use on the Photonics KTN web site at www.photonicsktn.org. It is intended to be an easy-to-use entry point for people who are looking for – or wanting to advertise – training in photonics-related subjects.

The range of courses available are aimed at scientists, engineers, technicians and others working in a variety of industries, including fibre-optic communications, industrial laser technology and optical design.

Only short courses for professional development are listed, on the grounds that elsewhere there is already good listings of academic courses.

Most of the UK's photonics firms are small to medium-sized enterprises, and they usually lack a dedicated human resource department to help them to source training for their employees. The Photonics KTN Training Portal provides a good place to start meeting this need.

The information is provided free of charge and no login is required to browse, search and filter the offering of courses and training providers. Trainers can create an account that will allow them to upload information about the courses that they offer and keep this up to date.

Easing access to research funding

For young technology firms where business is already high risk, options for tying up their own capital for long periods are limited. According to Alastair Wilson, the Photonics KTN Director, there are a number of ways that these firms can get support for research projects from both public and private sources but that, with more than 3000 of these to choose from, it can still be hard to locate suitable help.

Photonics
Knowledge Transfer Network

The Fundmap at http://www.fundmap.co.uk/ektn/ is a combined development of the electronics and photonics KTNs. It provides easy navigation to the grants and funding available to businesses in the UK technology sector: Using the graphic illustrated here visitors can search or filter for grants to match their current needs.

Looking to the future, The Photonics KTN is pushing to see the implementation of the funding recommendations in Lord Sainsbury's recent report on UK innovation. The proposed UK scheme, known as SBRI, is modelled on a US government procurement initiative that has had significant impact on its photonics industry. For additional information, visit funding.photonicsktn.org.

MEMBERS' NEWS

Powerful sales growth for Trumpf
In the 2007/2008 fiscal year the Trumpf Group achieved a sales growth of 10 % over the previous year, to approximately €2.14 billion. Trumpf President Nicola Leibinger-Kammüller expressed confidence about the next 12 months and forecast sales growth of around 5%."

Factors contributing to Trumpf's excellent results were the worldwide economy, which was still strong during the period, and the high demand for quality manufacturing and production equipment. All business fields enjoyed growth. The strongest was recorded in Europe.

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Sheffield Assay Office relocates
Sheffield Assay Office embarked upon the next chapter of its fascinating 235-year history when it moved into purpose-built 3000 m^2 building in Hillsborough, Sheffield.

Ashley Carson (first left) is pictured with members of the construction team bringing some of the panels back into the new library area

However, committed as he is to innovation and development, Assay Master Ashley Carson is keen to preserve the sense of history which has shaped the organisation. The old building at Portobello Street in the centre of Sheffield featured beautifully crafted oak panels, each bearing the date mark for every year of the Assay Office's history since 1773. These panels made the short journey across the city to the new building, where they were installed and the tradition will continue.

"In addition to the hallmarking services which were the reason for the Assay Office being established, we now offer a wide range of advanced laser marking and analytical services and our new home will ensure we have the space and facilities to develop them,"said Ashley.

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Rofin to acquire Chinese laser company
Rofin-Sinar Technologies will acquire 80% of the share capital of China-based Nanjing Eastern Laser Company (NELC) in two separate transactions.

Jointly established by Nanjing Sanle Group Co. Ltd. (China) and SIDA Corporation in 1993, NELC has over two decades experience in the Chinese laser market. The company has maintained a close cooperation with Rofin-Sinar since 1993 and has been authorised to manufacture SM COB2 Blasers using Rofin's technological knowledge since 2004.

The company's main product lines are high power, fast-axial flow CO_2 lasers, with a power range of up to 3 kW as well as NC-based laser processing equipment. NELC has approximately 70 employees and is ISO 9001-2000 certified. NELC will continue to operate as a stand-alone company and market its products through its own sales network to its primarily Chinese customer base.

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Lantek opens a new technical support office in Argentina
Lantek, developers and suppliers of CAD/CAM and ERP software for the sheet metal sector has opened a new service and support centre in Argentina.

The South American market has experienced rapid economic development, and there are prospects for significant growth in machine tools for sheet metal applications. Lantek has seen a considerable increase in demand for its CAD/CAM and ERP software in the region, and expects that this will rise as more sheet metal machinery is installed and requires the support of software solutions.

Joseba Pagaldai, Commercial Director of Lantek, said, "This is Lantek's 19th office. Since we opened our first office in France in 1991, we have developed a strategy to gain a large share of the international market. Over 70% of our turnover is from international sources and we exceeded 8,200 customers from more than 90 different countries in 2007. Our success is an endorsement of the technical superiority of our CAD/CAM and ERP solutions and the value we can bring to our users."

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Powerlase receives 2008 Business Achievement Award
Powerlase Ltd, manufacturers of powerful nanosecond Q-switched, diode-pumped solid state (DPSS) lasers, has been awarded The Business Achievement Award 2008 by Clarke Willmott for being the fastest growing technology business.

Powerlase's rapid growth rate is a reflection of its established success in plasma display screen manufacturing. The company has strengthened its position as a global laser supplier through the development of dynamic distribution channels, enjoying direct and channel operations in Mainland Europe, Korea, Japan, Taiwan and China.

Alongside Powerlase's development in the flat panel display (FPD) market, it continues to develop products and applications for future markets, driving innovative breakthroughs in the field of Extreme Ultraviolet Lithography. Additionally, Powerlase's new 100G and 200G lasers have been developed to cater to end-user needs and are being used to benefit the solar cell processing and AMOLED screen display markets.

"We're delighted to be acknowledged for our work in the FPD market," said Mike Mason, Vice President of Technology at Powerlase. "Our impressive growth is a direct result of our customer-led applications-driven approach to laser manufacture. By putting the needs of our customers and partners first, we're continuing to develop exciting new products for new markets which will see us grow into 2009 and beyond. It is a very exciting time for Powerlase."

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New funding for optoSiC
OptoSiC of Baden-Baden, Germany, the developer of dynamic Silicon Carbide optics, has received significant investment from ATON Prisma GmbH.

"The investment will allow optoSiC GmbH to strengthen, and to rapidly grow and expand sales of its revolutionary optoSiC+ low-cost, high-performance laser beam guidance and scanning mirrors," said Technical Director Steve Hastings.

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Laserite moves to Basildon
As part of its ongoing rapid expansion Laserite, Essex based laser cutting and marking systems provider, has relocated business from Brentwood to Basildon.


Laserite's new building in Basildon

The new facility of 680 m^2 hosts a very wide range of CO_2 and YAG laser cutting, marking and engraving devices.

The new facility hosts over a dozen demonstration machines within two showroom areas amounting to 100 sq.m as well as significantly improved production, support, sales, warehouse and office spaces.

Dean Carpenter, Director, comments "With the phenomenal success of our Lotus product range we simply didn't have the space to cope with the upsurge in sales. At Basildon we were able to create a bespoke facility to provide us with sufficient space to store and service machines for current and foreseeable future demand."

As well as increased space Laserite has added more staff and other resources to support the systems it supplies. See www.laserite.com for further details

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Vero Software relocates head office
The head office of Vero Software Plc., a leading supplier of CAD/CAM software to the mould and die sector, has a new and more spacious location in Cheltenham, UK, bringing together Vero Software Plc and its subsidiaries Vero UK Limited and Camtek Limited into a single office.

"Our decision to relocate will streamline and consolidate the business," comments Don Babbs, Chief Executive. "The combined office with more space and a more central location is in line with our proposed plans for group expansion."

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II-VI receive Certificate of Appreciation
II-VI Infrared's Bob Ireland (VP, technical marketing and sales) and Gary Herrit (senior optics design engineer), along with II-VI Japan's Hidekatsu "Dj" Matsuyama (sales manager) and Yasuhiro "Saki" Sakakibara (president of II-VI Japan) met with senior personnel at the headquarters of Mitsubishi Electric Corp.

During the meeting, Bob and Saki (on behalf of II-VI) received a "Certificate of Appreciation" award presented by Mr. Hiroaki Katayama, deputy manager of Mitsubishi's laser division, for II-VI's valuable contribution to Mitsubishi's laser systems production. All units from Mitsubishi's laser division were in attendance, including high-power resonator and system design and manufacturing, low-power resonator and system design and manufacturing, and via hole system design and manufacturing.

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Auxiliary equipment

Victor Manufacturing realise 48% energy savings

AILU member Victor Manufacturing is a leading commercial catering equipment manufacturer. At their manufacturing site in Bradford an extensive range of food service equipment is manufactured which is used by all kinds of organisations including hotels, restaurants, hospitals and universities to move, store and serve hot and cold foods.

Compressed air is used within the manufacturing process to power various applications such as the assembler's air tools.

As part of a company wide energy drive. Victor Manufacturing invited The Carbon Trust to audit the compressed air system and assess its energy efficiency. Amongst the recommendations made, the Carbon Trust identified that energy savings could be made by replacing the existing compressor with an energy efficient version.

At this stage Bob Morris, the Production Supervisor, invited current compressed air partner Boge Compressors to review the system. Dale Cellier, Boge's Area Sales Manager conducted an audit that independently verified those of The Carbon Trust – that energy savings would be made by replacing the existing compressor with an energy efficient compressor. The Boge SLF40 frequency controlled screw compressor was recommended.

Bob Morris said "The quantified energy savings were significant enough to convince us that investing in an energy efficient compressor would pay off in the long run.

Our experience with Boge to date has been excellent. We already had one Boge compressor installed over 12 months ago to power the laser cutting application which had run satisfactorily. In that time Boge had provided us with excellent service and backup support. As a result we chose to install a Boge SLF40."

The Boge SLF series combines a direct coupled drive system with frequency control to provide the ultimate compressor for pressure control under variable output requirements. The SLF is therefore a low carbon technology that works strictly in accordance with the compressed air demand by producing the exact volume of compressed air at the pressure required. Frequency control minimises idling time and evens out air demand fluctuations. For Victor Manufacturing this meant creating a 48% reduction in their compressed air energy costs per annum!

Bob Morris concludes: "We have since been very satisfied with the performance of the Boge SLF40 – we don't have to think about the compressor system any more – it's just doing its job, saving us money and contributing to our all up reduced carbon footprint!"

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Air Products showcases services to laser cutting systems
From its UK headquarters in Kidderminster, Worcestershire, Amada operates one of the UK's largest dedicated Technical Showroom providing demonstrations of state-of-the-art laser cutting systems and other machinery to over 1200 visitors each year.

Earlier this year, Amada UK decided to upgrade the gas supply system in their Technical Showroom to help demonstrate the very latest laser cutting systems. Working in partnership with Air Products, the company opted to introduce the CryoEase® microbulk gas supply system, which would allow them to demonstrate the benefits of continuous usage. Instead of using traditional cylinder packs, the new gas supply system has a storage tank, which can be located anywhere onsite and re-filled with liquid nitrogen using a special high pressure filling system, thus avoiding downtime caused by the need to vent down tanks.

Using liquid gas rather than gas cylinder packs also means that when demonstrating the latest laser cutting machines to their customers, Amada UK can be sure that there is no interruption caused by the need to change over cylinders, as Dave Goves, senior engineer at Amada UK, who is responsible for managing the technical demonstrations, explains: "There is nothing more annoying than starting a demonstration on a brand new piece of equipment and being forced to stop to change over cylinders. The customer wants to see the machinery operating non-stop and the CryoEase® gas supply system enables us to do that reliably every time."

Amada UK offers a full range of automation systems for its lasers and over recent years has seen automated laser systems become more popular. With over 40% of laser users opting to automate their machinery, a continuous gas supply is vital in order to operate 'lights out' production.

Andrew Cornes, CryoEase® service manager at Air Products, says: "In addition to our ability to provide liquid gases at micobulk volumes, we can now refill tanks with liquid nitrogen at a pressure suitable for laser cutting applications – usually around 30 bar. This means more operators of laser cutting machines can benefit from continuous operation."

Andrew Cornes advises: "The storage capacity of our smallest CryoEase® system is 180 litres and in most cases we advise production managers that if they are using more than 10 cylinders of high-purity gases per month it may be worth switching to liquid storage. This will improve efficiency and bring other benefits too. For example, liquid storage can also be safer because it eliminates the need for cylinder handling and compressed gases can also be stored at a lower pressure. "

For more information about the CryoEase® service contact Air Products by phoning 0800 389 0202 or visit www.airproducts.com/cryoease.

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Laser sources

SPI lasers developments
SPI latest air-cooled lasers increases in power from 100 to 200W power and water cooled from 200 to 400W power, and provide an extended range of laser control functions.

"The power, versatility and control capabilities of SPI's R4 Platform Products make them the most advanced high power fibre lasers on the market today, enabling ground breaking process improvements." said Andy Appleyard, Product Line Manager for High Power Laser Systems.

New features on the R4 laser platform include XPR (Extended Performance Range) and PSE (Pulse Shape Equalization). These new features build upon SPI's traditional market leading performance in CW laser stability and superior modulation rate (CW to 100KHz). XPR allows a high power laser to be switched to operate at average powers down to <1% of the maximum rated output power, a factor of ten improvement over SPI's closest competitors. The PSE feature overcomes the traditional laser problem of first pulse over or under-shoot. PSE ensures the first pulse is as useable as the any other in the pulse train. And SPI's flagship system with 400W of water cooled output power can be ordered in either single-mode or multi-mode output beam configurations allowing process optimization for either fine kerf cutting or welding applications.

David Parker, Chief Executive Officer of SPI Lasers, welcomed the releases; "It is clear that the fibre laser is now an accepted tool of choice in many applications. The 400W laser enables SPI to participate in a wide number of new fields, notably in the welding arena."

Extended operating temperature range
The operating temperature range of SPI's 20W pulsed fibre laser has been extended. The new ST 'Superior Temperature' variant of it successful G3 20W pulsed laser is capable of operation in ambient environments up to 43°C (HS model has a 35°C upper limit). This is ideal for hot climate geographies.

The ST typically gives 21W and is specified to give >20W under all environmental conditions. Typically, the ST has a 5% improvement in pulse energy, average power and peak power over the 20W HS.

Jack Gabzdyl, Product Line Manager for Pulsed Fibre Lasers, welcomed the release; "The 20W pulsed laser is ideal for general marking, micromachining and engraving as it can produce deeper and narrower marks but now comes with the benefit of the ST feature. ST ability allows SPI to become leaders in hot climates such as Asia & South America where manufacturing industries are opting for more advanced fibre lasers."

A proof of concept and try before you buy program can be found on the SPI website at www.spilasers.com and registering your details on the 'Try before you buy' page.

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QPC's Ultra-600 laser diode module delivers power and brightness

Pro-Lite Technology LLP has released the Ultra-600 from QPC Lasers, a high power laser diode engine which delivers high spectral and spatial brightness for enhanced pumping of fibre lasers.

QPC's Ultra-600 diode laser module features on-chip Brightlock™ internal grating and Brightlase™ technology resulting in higher powers and improved spectral brightness from 100 or 200 µm core fibres for Yb, Er:Yb and Tm fibre laser pumping. Over 300 W total CW output power is available "cladding-free" at 976 ± 1.5 nm. 450 W CW is offered at 792 ± 3 nm. The Ultra-600 is a fully plug-and-play. Options include QPC's Ultra-Drive™ benchtop laser diode driver and Ultra-Therm™ water cooled chiller.

QPC Lasers is a world leader in the development, manufacture and distribution of high-brightness, high-power semiconductor lasers. Founded in the year 2000, QPC is vertically integrated from epitaxy through packaging and performs all critical fabrication processes at its facility in Sylmar, CA, USA.

QPC has developed patented and proprietary high brightness chip-based laser technology with the potential to reduce the size, cost, and weight of lasers by as much as 10X while significantly improving energy efficiency and portability.

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Newport adds to its Excelsior® Family

Newport's Spectra-Physics® Division unveiled the new Excelsior®-594 laser. This latest addition is a state-of-the-art multi-longitudinal mode laser with 30 mW output power at 594 nm. It is an ideal solution for Flow Cytometry and emerging Microscope and DNA Sequencing applications.

"Three years ago, when we introduced our first Excelsior laser, our goal was to provide a complete product family of lasers for the next-generation

applications being developed by our leading OEM customers," said Jürgen Niederhofer, Product Manager for Spectra-Physics. "Over the last 3 years we have expanded the product offerings, and today we are very excited to release the twelfth member of the Excelsior family. We are one of the only companies in the industry that can deliver a complete line of low power CW lasers from 375 to 1064 nm for demanding semiconductor and bioinstrumentation applications."

Spectra-Physics' Excelsior laser platform includes low power CW lasers at 375, 405, 440, 473, 488, 505, 532, 561, 594, 635, 785, and 1064 nm. Every Excelsior laser delivers a stable output power over a wide temperature range.

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Photonics Solutions offers a range of new laser sources

Compact picosecond amplifier offers 30W at 500 kHz

High Q Laser is offering the most compact, all-in-one picosecond amplifier available on the market. Measuring just 78 x 34 cm, the picoREGEN™ UC-Industrial amplifier supplies 12 ps pulses at single shot to 500 kHz at 1064 nm with a power of up to 30 W.

Distributed in the UK by Photonic Solutions, this high-power, ultra-fast regenerative amplifier has been specifically designed and tested to meet industrial demands. Ideal for high speed micro- and nano-processing with applications in precise laser ablation in metals and ceramics, semiconductor processing, thin film ablation etc.

More information at:
http://www.photonicsolutions.co.uk

High power near IR fibre-coupled diode laser with full feedback protection

JDSU's 6398-L4i series fibre-coupled diode laser offers full fibre laser feedback protection from any fibre laser wavelength, allowing end users to operate the fibre laser in an environment virtually free from the risk of feedback to the diode laser.

The L4i series fibre-coupled diode laser is the latest solution in JDSU's L4 platform for the fibre laser pumping market, offering 10W of CW power from a 105 mm fibre into a 0.22 or 0.15 numerical aperture.

Distributed in the UK by Photonic Solutions, it is available at three wavelengths: 917 nm, 939 nm and 974 nm, the L4i multimode pump module also takes advantage of the existing global JDSU manufacturing infrastructure to offer both high brightness and a small footprint, with consistent high reliability in a cost-effective solution.

World's most powerful mini excimer

The EX5 excimer laser manufactured by GAM Laser, Inc. and distributed by Photonic Solutions is a genuinely low cost, compact, mini excimer laser, weighing in at only 14 kg, measuring 47 x 25 x 25 cm and supplying up to 7.5 W at 248 nm and 3.5 W at 193 nm.

The air cooled EX5 is fully computer controlled and features on-board vacuum pumps and halogen filters. It offers excellent tube, optic and gas lifetimes and excellent pulse to pulse stability. It is ideally suited to applications in micromachining, laser ablation, laser ionization and OEM products.

High Q - femtoTRAIN IMAGING

High Q Laser has released a new femtosecond light source for multi-photon microscopy. The new model "femtoTRAIN IMAGING" is a compact, all-in-one, all diode-pumped, Ti: Sapphire oscillator. It provides light pulses with a duration of 100 fs at an average power of 200 mW, at fixed centre wavelengths of 790, 810, 850 or 870 nm, It is the ideal femtosecond laser source for two-photon microscopy.

Dye laser for high PRF & pulse energy

Sirah has launched the Allegro dye laser. Distributed in the UK by Photonic Solutions, the Allegro is optimised for use with high repetition rate diode pumped solid state laser systems. Pumped by multi kHz 532 nm and 355 nm lasers the dye laser can be configured to lase from 370 nm – 900 nm with fundamental wavelength output power of up to 25 W.

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Coherent sources

OEM ultraviolet laser delivers low beam divergence

The new MATRIX™ 355 BE from Coherent is a frequency-tripled DPSS (diode pumped solid state) laser that delivers a unique combination of low output noise and low beam divergence. This is the first OEM UV laser to incorporate an integral beam expander within the sealed laser head, resulting in an output beam diameter (1/e^2) of 2.2 mm and a divergence of only 0.5 mrad. This low divergence is an advantage in many OEM applications, especially those having particularly long beam delivery paths or requiring high NA focusing. The new laser is offered with a choice of 1 or 2 watts of average power and pulse repetition rates as high as 60 kHz.

The MATRIX 355 BE is optimized to deliver long-lifetime operation for precision applications in materials processing and marking.

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The LPXpro – a Classic Goes Green

The LPXpro excimer laser product line is now adjusted in its third generation to the environmentally-friendly requirements of the RoHS directive. It offers a completely revised controller unit and extended warranties and features the best gas and component lifetimes at the market due to clean room production technology. Flexible operation provides output at 193, 248 or 351 nm. The C-version has a special 308 nm configuration. 157 nm are available with the dedicated LPFpro series.

Due to its wavelength and the short pulse length a broad range of applications including micro-machining, PLD, LDP, LIDAR and annealing can be processed with these lasers. Visit www.coherent.com/excimer for more information.

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GSI enhances JK fibre laser range

GSI Lasers has enhanced its range of JK fibre lasers with a new Low Profile 200 W OEM fibre laser. This is a compact version of the OEM packaged laser with dimensions of 330 x 330 x 125 mm high: a 30% reduction in size from the original product, making it one of the smallest on the market. Despite its size there has been no compromise in performance or product lifetime and the compact size allows the unit to be integrated into smaller systems, with the high power allowing fast process cycle times.

To further enhance the applicability of the laser to a small system GSI has also recently introduced a more flexible conduit for the beam delivery fibre, allowing a tighter bend radii when routing the fibre conduit from laser head to process tool, yet still provides an appropriate level of protection for the enclosed fibre.

Greater flexibility with local control
For applications and installations that require local manual control of the laser, the new laser in the JK fibre laser range does not need an external control system. Available in 19" rack mount packaging and providing the same level of protection to the laser and the user as other lasers in this range, it offers extra status information delivered through indicators on the front panel. This simplifies the installation requirements for system integration. Also, it is not necessary for the integrator to install external safety shutters in order to comply with the latest international laser safety standards.

For those times when it is necessary to set the laser parameters up in more detail, the laser still offers the same fully functional RS232 interface and ability to use the FibreViewTM GUI software that enhances the user friendliness of the whole JK Fibre Laser range.

User-friendly software
Since the JK Fibre Laser range was introduced in 2007, GSI has brought leading technology to the industrial laser market whilst delivering products that are rugged, easy to integrate and optimised for industrial applications. Key to this is the FibreView™ Graphical User Interface (GUI), which allows full control over the CW and Pulsed modes of operation of the JK Fibre Laser range.

Fibre View™ greatly aids the ease with which system integrators and end users can immediately benefit from the advantages of their JK Fibre Laser offers benefits including:

- Easy programming of laser parameter sets/pulse shaping.
- Process vision - CCTV cameras fitted to the process head and displayed within the Fibre View™ screen. This saves on cost and space needed for a separate monitor. The module also has cross hairs for laser process area alignment, and cursors to allow for measurement of features on the display.
- Data Logging of all alarms/events/ warnings.
- Laser metrics

More information can be found at www.gsiglasers.com

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MEMBERS' NEWS

Rofin-Baasel extend capability of patented sweet spot resonator®

It is now ten years since Rofin-Baasel Lasertech invented the sweet spot resonator®, and in doing so set a new standard in the development of solid state laser sources.

This patented resonator technology provides excellent pulse-to-pulse stability combined with a large depth of field. Today, a new third generation system now extends the sweet spot resonator technology into the 200 W average power range.

First- pulse effect eliminated
Excess heat inside a YAG rod which is water cooled on the outside (a standard feature of Nd:YAG lasers), creates a "thermal lens" which is influenced by the average power level. This induced thermal lens changes the divergence of the laser beam which can lead to a variation in spot size and penetration depth during the course of a seam weld. Rofin's patented sweet spot resonator® ensures that the characteristics of the first laser pulse are the same as the last thus eliminating any weld variation.

Consistent manual welding
The pulse-to-pulse stability and large depth of field, both key features of the sweet spot technology, enable excellent results to be obtained in manual welding applications. The high beam quality means greater depth of field, a decisive advantage for hand welding applications. Another area where the sweet spot resonator® technology has proved to be especially effective is in the field of processing highly reflective materials such as copper, gold and silver. These materials are commonly used in jewellery production and the dental industry, where laser welding is fast becoming the preferred method of joining. Rofin's sweet spot resonator® technology allows processing of the finest and most delicate components with weld spot diameters smaller than 100 µm using Rofin's MicroWeld™ function.

New application areas
Seam welding applications on sheet metal is one area where the advantages of the sweet spot resonator® can be clearly seen. The consistency and predictability of the process, achieved from the excellent beam quality, vastly reduces the setup and development times normally associated with welding on thin metal components. The high pulse-to-pulse stability produced also ensures process reliability. This is particularly important on components such as medical devices and implants where fine tolerances and high quality must be achieved on each and every part.

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Beam Delivery

Newport Introduces the SmartTable® OTS™ Optical Table System
Newport Corporation have released the SmartTable® OTS™ optical table system. This latest vibration isolation system combines Newport's SmartTable® optical table family with a new, innovative isolation platform.

The new OTS™ platform integrates Newport's I-1250 pneumatic isolator with a rigid frame to deliver an isolation platform with superior performance and unmatched accessories. According to Warren Booth, product manager for Newport Corporation, "Integrating this isolator into our new OTS platform provides high performance, reliability and ease-of-use. As system requirements and budgets change, users can easily upgrade their system to improve performance, organization, laboratory space and productivity. The SmartTable OTS platform is also the only optical table system that is field upgradeable with four levels of table performance and three isolation options."

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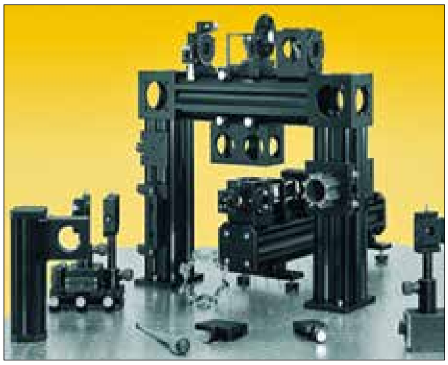
Pro-Lite's SYS 65 Optical Rail System Gives Rapid Results



Pro-Lite Technology has released the SYS 65 optical rail system from OWIS. The system comprises a modular series of optical rails, slides and mounting accessories that allows the researcher to create and modify experimental beam handling setups quickly and easily. The rails maintain a fixed optical beam height above the mounting surface and are available in a range of options including 4-sided profile rails for 3D assemblies.

The OWIS rail system is elegant and simple. Slides are mounted on a rail and optical components are directly mounted on the slides. A wide range of manual and motorised positioning equipment is available for use with the system, including goniometers and stages for angular adjustment, elevation, linear translation, rotation and XY positioning. Overall, the stability and flexibility of the OWIS SYS 65 rail system results in faster and better results in both R&D and industrial applications.

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New scanning systems for GSI JK pulsed laser

New JK scanning systems for the JK125 and JK300 are now available for GSI's range of industrial lasers for welding, cutting and drilling. The new Scanning Systems can be configured to meet customers' high speed and precision repeatable seam and spot welding requirements. A key feature of the new scanners is the powerful LaserView SE user interface, which enables seamless programmability of scanner and laser parameters through a single operator screen.

The scanning head enabling the beam to be deflected precisely and quickly throughout a range of spot sizes and working areas. Two configurations are available, a Fixed Spot Size range and Variable Spot Size range.

Successful laser welding depends upon the selection and proper application of the right laser system and basic laser welding and fixturing techniques. The new Scanner Systems are defined by the ability to select a specific combination of modules to meet any given specification.

The Variable Spot Size range provides the capability of x2.8 beam expansion and can be fitted with an in line camera adaptor which will accept a standard C-mount camera. The Fixed Spot range also accepts a C-mount camera fitted to the rear of the fibre output housing.

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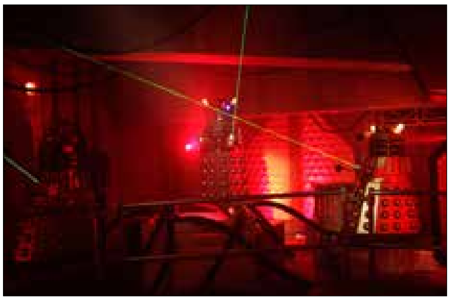
Component Handling

Trio starter kit moves Daleks to a stage managed clash with Dr Who®



London based Windmill Studios provide audio-visual solutions for the conference, live events and attractions industry and when Trio Motion launched its recent special offer for evaluation kits, it seemed an ideal opportunity to try out the Aerotech MC206X motion controller whilst saving costs for a special effects project that involved animating Daleks for the Dr Who Up-Close Exhibitions. (http://www.doctorwhoexhibitions.com/).

The MC206X Starter Kit from Aerotech includes the motion controller configured to suit the axis count and drive technology required along with all the cables, SD card memory, software and manuals required for the job in hand. The kit is aimed at all new customers on a one-per-customer basis.

For Windmill Studios, the MC206X controlled each Dalek's floor movement via a two-axis servo motor driven carriage and with its own on-board digital I/O and an additional 16 channel CANbus I/O module, also sequenced the start-stop positioning of several brushed DC motor driven axes for the rotating and vertically actuated head, the Dalek's famous 'gun-stick' and manipulator arms, as well as handling a variety of synchronised lighting and mechatronic effects.

According to Dave Black, a Windmill Studios Project Manager with over twenty years experience in the industry, "I found the Trio MotionPerfect2 development software easy-to-use for configuration and programming. The project-based approach along with the axis and I/O monitoring, and the simplicity of the Trio BASIC language allowed for really fast application development."

The flexible MC206X is aimed at small to medium sized control applications in manufacture and test, process control, and research – not just for alien life-form simulation!

Other news: motion designer software
Aerotech's new Motion Designer software generates and analyses motion trajectories and improves the performance of complex motion profiles. The software simplifies trajectory programming and reduces the time for simulating a dynamic environment or real-world conditions. For use with Aerotech's wide range of motion controls, the add-on software is aimed at test and development applications for motion and movement measuring components but will also be of interest where increased performance and production throughput is required.

Other news: vacuum preparation tutorial
Aerotech has recently updated and expanded the Vacuum Preparation section of its Engineering Reference tutorial. Available online at the www.aerotech.com website in HTML or in downloadable PDF format, the section details important design considerations and recommendations for high precision motion control systems in vacuum. Issues addressed include materials selection, surface finish, outgasing, and lubrication.

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Software

Lantek Expert for multi-processors
Lantek has completely revised the architecture of its Expert II and Expert III systems. The software packages have been optimized and adapted to take advantage of the capabilities of computers equipped with dual-core or quad-core processors, achieving increases in processing speeds of between 30 and 40%. Particular focus was placed on tasks that require intensive processing, such as part nesting.

The new architecture provides further advantages by optimising and reducing work preparation times which, combined with the faster nesting and machining, generates significant savings. Overall, the re-engineered software improves quality and competitiveness, cuts response times and reduces administrative costs, energy consumption and material usage, enabling users to provide a better and more cost effective service to their customers.

This new development offers more flexibility and total compatibility with third-party hardware and software, and easy integration with all of Lantek's products.

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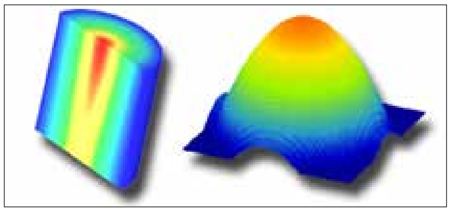
Pro-Lite's laser cavity design software
Pro-Lite has released LASCAD 3.5.4 laser cavity design software. It incorporates Dynamic Multimode Analysis (DMA) to improve the design of actively Q-switched solid state lasers, allowing:

- Computation of the shape and power of Q-switched pulses.
- Computation of the power within individual transverse modes.
- Computation of the M^2 beam propagation factor.
- Modelling the effect of apertures on beam quality.
- Modelling the effect of resonator mirror reflectivity profiles.



The software contains all of the simulation tools necessary to accurately model the performance of a laser resonator.

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Measurement

Laser lines expands measurement options

Real time, high power CO_2 laser profiler

Ophir-Spiricon recently released the II-VI-CO2-58 Industrial Laser Beam Analyser, a laser beam profiling system that enables the quantitative measurement and viewing of high power CO_2 beams. The system diagnoses faults quickly, in real-time, and corrects issues related to beam stability, alignment, tuning, and optimisation.

The II-VI-CO2-58 is a portable device that can be used to quickly and easily spot check performance on a variety of laser-based machines. The system has a 58 mm clear aperture and the ability to handle up to 10 kW of power, making it ideal for high power CO_2 lasers. With the ability to produce up to 48 images per second, users can view transient laser performance in real time. Other systems can take up to 10 seconds to create a single image and mask real-time transient responses.

"Until now, it was impossible to study the transient effects of high power laser processes in real time," stated Ephraim Greenfield, VP Engineering, Laser Measurement Group, Ophir-Spiricon, Inc. "In a one half second CO_2 weld, for instance, the part may burn one-third of the way through the weld. With the II-VI-CO2-58, you can see, in real time, when the laser beam is getting too small and too intense before the weld is complete. This allows for faster diagnosis of problems, a significant increase in quality parts, as well as lower scrap rates and less downtime."

Upgraded M^2 beam propagation analyzer

Ophir-Spiricon has announced major upgrades and reduced size of their 200S Beam Propagation Analyzer. The M^2-200S upgrade includes: a size reduction to 50% that of its predecessor; measurements reported 2-3 times faster; and a more robust construction, insuring 24/7 reliability.

These upgrades provide:

- Automatic M^2 values at production speeds, thanks to more efficient algorithm execution. M^2 values can be reported in under two minutes.
- Improved accuracy thanks to Ophir-Spiricon's proprietary method of using software apertures to exclude noise beyond the wings of the laser beam. This contributes greatly to beam width measurement accuracy.
- Increased reliability thanks to endurance testing of critical components, aimed at continuous 24/7 use.

The M^2-200S is the only ISO compliant system for all reported measurements.

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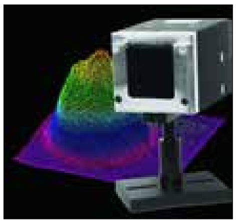
Large area laser beam profiling system

Spiricon has recently released the USB L11058 Large Format Beam Profiling Camera. The USB L11058 is designed for measuring large ultraviolet laser beams. It's high resolution, 4008 x 2672 pixel format allows profiling of beams up to 24 x 36 mm without requiring reduction optics. Frame rates of up to 3.1 frames per second at full resolution increase throughput and productivity. This makes the USB L11058 ideal for use in applications that require a large field of view, fast frame rates, low noise, and high responsivity, such as high power lasers in semiconductor fabrication.

The USB L11058 Large Format Beam Profiling Camera accurately measures CW laser beams over an extensive spectral range, from 190 nm to 1100 nm. The camera also has a wide dynamic range of 59 dB and features a global shutter which allows simultaneous integration of the entire pixel array; its short exposure time is ideal for capturing objects in high speed motion. An integrated USB 2.0 digital interface allows users to transfer measurement data to laptops and desktop computers.



"The USB L11058 is the industry's largest area laser beam profiling camera on the market," stated Gary Wagner, President, Spiricon, Inc. "This innovation allows the profiles and widths of laser beams that were previously too large to be captured and analyzed, aiding accurate measurement and cavity alignment, and significantly improving the quality of the finished product."

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Laser Physics introduce a compact handheld laser power/energy meter

Scientech has introduced a new line of calorimeter laser measurement systems utilizing their new intelligent detector technology. Designed to be very robust, these new systems consist of a handheld meter and a choice of thermal detectors including 8 mm, 16 mm, 25 mm, 50 mm, 100 mm, and 200 mm aperture models. Also new is an optional field calibration tool that allows the user to easily calibrate detectors without having to send them back to the factory for annual calibrations.

The Astral Series S AI310 or AI310D indicators are compact, portable, handheld devices in a rugged, metal case. The AI310 marries both a 4-digit LCD display along with a true analogue needle meter movement to aid laser tuning. The AI51D is the digital only version of the AI51. The meter can be powered either by the standard wall mounted power supply/battery charger, optional USB data interface, or optional battery.

The Astral Series S detectors are available in surface and volume absorbing models. The surface absorbing models are ideal for CW laser beams while the volume absorbing models are for pulsed lasers using either the watts mode or single pulse energy mode. Some large aperture models will measure up to 1000 joules of single pulse energy.

Each detector comes with a NIST traceable calibration certificate to ensure that the user is getting the most accurate laser measurement possible.

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Pro-Lite offers pulse energy measurements with EnergyMax

Pro-Lite Technology has released the EnergyMax pyroelectric laser energy sensors from Coherent. These sensors aimed to set new standards in pulsed laser measurements in terms of linearity, damage threshold, extended dynamic range and broad spectral response, providing highly reliable readings.

EnergyMax sensors provide energy measurements with all laser types, from nJ to Joules, from 190 nm to 12 µm and from femtosecond to 860 µs pulse duration. They provides superior damage resistance up to 14 J/cm^2 and higher repetition rate operation, from single shot up to 10 kHz. With the new LabMax meter, the energy from each pulse at 1 kHz can be recorded.

Flexibility is assured through a wider dynamic range (4 decades using a single sensor), and the choice of three, large sensor areas (10, 25 & 50 mm). On-board temperature compensation and user-attachable heat-sinks provide for reliable operation with higher average power lasers. Extensive testing by Coherent was confirmed that shocks, vibration and humidity do not affect readings.

EnergyMax detectors are available in four types, each optimised for a different application: general purpose; YAG & harmonics; high rep rate; and excimer.

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Process

Cutting and welding

Fine Welding Lasers from Rofin

With a complete family of laser sources and systems, backed by almost 30 years of application experience, Rofin-Baasel is able to provide the optimum combination of laser source, system and accessories for all fine welding applications. The range of lasers and systems includes fibre laser sources, pulsed YAG rod laser sources, manual & CNC welding systems.

StarFibre

A range of compact and robust fibre laser sources are available with a power range of 100 to 200 W, a range especially suited to the finest of welding applications. The performance of these lasers is further enhanced by the low inertia scanning head which enables high welding speeds to be achieved over a large processing field. StarFibre lasers produce precision welds on components such as batteries, fuel cells, sensors, electro-mechanical components and medical components.

StarPulse

The StarPulse series of lasers is a new generation of pulsed YAG rod lasers with power ratings from 40 W to 500 W. StarPulse lasers offer the largest range of pulsed peak power available on the market. Precision welding of delicate components is achieved using the accurately controlled low end pulse peak power of 10 W. With up to 20 kW of pulsed peak power available, high quality welding on highly reflective materials such as aluminium and copper up to 2.0 mm thick can be achieved at high processing speeds.

The Rofin Control Unit (RCU) employs Double Closed Loop ™ principles which guarantee excellent pulse to pulse repeatability with <1% variation even at lowest pulse energies. Precisely controlled pulses of only a few mJ of pulse energy are used to weld extremely thin wires of 50 µm diameter or to produce seam welds in thin section metal parts.

Laser Welding Systems

Rofin has a wide range of welding systems available. The Desktop is the smallest and most cost-efficient of these and is also used extensively in the production and repair of crowns and bridges within the dental industry.

Rofin's StarWeld

The Performance laser welder is particularly popular in the jewellery sector. The components are hand held underneath the laser beam, with the precise location of the laser weld accurately viewed through a microscope.

StarWeld Select is an ergonomically designed and fully integrated laser and highly flexible welding system. It includes four high precision axes and joystick or CNC control.

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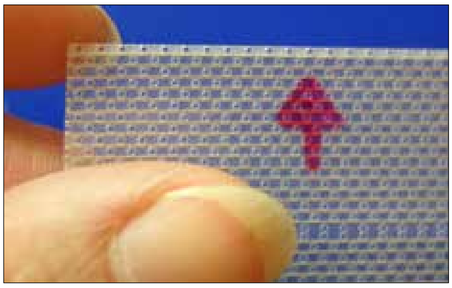
Synrad laser cutting

<u>Cutting Polyester Ribbon Cable</u>

Ribbon cable is commonly used in the computer and electronics industry to transmit multiple bits of data in parallel between other cards or peripheral devices. Today, ribbon cables are also in common use in products ranging from appliances to automobiles as manufacturers integrate an ever-expanding array of computerized controls and sensors in an effort to increase product reliability, safety, and performance.



Using 10 W of power and 1.4 bar of air assist, lengthwise cuts were made through this polyester ribbon cable at speeds of 12 m per minute

One type of ribbon cable, shown in the photograph, comprises multiple copper conductors encased between two sheets of 25 µm thick polyester film. Polyester film (also known as Mylar®) has excellent dielectric properties and is an effective insulator in electrical applications.

Depending on the width of the data bus required (8, 16, or 32 bit) this ribbon cable, with an assembled thickness of 0.44 mm is cut lengthwise to create one or more groups of eight conductors. Using 10 W of laser power and a 1.4 bar air assist, lengthwise cuts were made between groups of conductors at a line speed of 12 m/min. The resulting cut edge is exceptionally smooth with no dross or discoloration present.

<u>Printed Circuit Board</u>

When using automated equipment to manufacture small PCBs (Printed Circuit Boards), it is far easier to fabricate boards and insert components while working with a single large board. PCB designers accomplish this task by nesting many smaller boards to fit within the confines of standard size boards.

The first photo shows a partial view of a 20-up board where 20 smaller boards are contained within the larger parent board. After board fabrication and component insertion is complete, individual boards are cut from the parent board prior to integration into the final product.

Continued over ...

Case Study

£800,00 investment

Swelco, the sub-contracting and sheet metal fabrication division of Altron Communications Equipment Limited, one of the leading suppliers of CCTV mounting equipment, has placed an order with Bystronic UK Limited for equipment valued in excess of £800,000. The order comprises a Byspeed 3015 laser cutting system equipped with ByTrans, the intelligent solution for loading and unloading; a rotary axis for an existing Bystar laser cutting system; and two high-specification Bystronic Beyeler Xpert press brakes.

Sixty per cent of Swelco's work comes from external customers whilst the remaining 40 per cent is on behalf of Altron. The company uses a wide range of equipment including an existing Bystronic Bystar 4020 with 4 kW laser source as well as two lasers cutting systems supplied by another manufacturer. In order to allow Swelco to expand into new markets and to consolidate its current activities such as flame and jig cutting, the company took the decision to retrofit a rotary axis to the Bystar system with a tube processing capability up to 315 mm diameter.

As part of its expansion plans Swelco has also decided to replace the two older lasers with a Byspeed laser cutting system with automation. This system will provide Swelco with the additional capacity to grow existing business as well as expand its sub-contract customer base.

The decision of which laser cutting system to purchase was not taken lightly and the whole process took many months. Swelco firstly worked out the required capacity, the materials the new machine would be required to process and the overall competitiveness. Having selected the Byspeed out of the Bystronic range bench mark tests were carried out on the Byspeed as well as competitor systems.

Steve Jones, Swelco's managing director comments: "When looking at machines to trial we felt the Byspeed with ByTrans would suit our future demands in terms of material utilisation and thickness; and overall speed. We ran a series of tests over different nests and in one 6 mm nest our existing older laser took 1 hour 24 minutes, the Bystar produced a similar result whereas the Byspeed cut the nest in just 34 minutes! The speed of the machine was electrifying.

"It was not just the speed and quality of the machine that gave Bystronic the order. It was the quality of the organisation, its service and after-sales facility. The ByTrans system will allow us to venture into automation and lights-out production for the first time and we need to be assured that support will be there should we need it. We also have the Team software which will allow us to control and analyse the cutting process.

"It was also suggested that we invest in a nitrogen generation facility through a third party. This will allow those components usually cut with oxygen to be cut with nitrogen, thus reduced cutting times even further and allowing us to be come more competitive."

In addition to improving its laser cutting facility, Swelco wanted to further improve its pressbraking facility. The two Bystronic Beyeler Xpert pressbrakes (one a 320 tonne x 4 metre model, the other 150 tonne x 3 metre) will replace three older machines. Overall it is anticipated these two new pressbrakes plus one existing machine will do the work of five pressbrakes.

Steve Jones continues: "With the Beyeler Xperts' interchangeable tooling and quick set-up times resulting in reduced machine down-time, I envisage a 30 per cent improvement in capacity and accuracy. Investing in a single source supplier was a major factor as was the consistency of the Beyeler Xperts and the ease of programming. The larger 4 metre machine is equipped with tooling to bend deep channels and the lifting aid on the machine will be invaluable"

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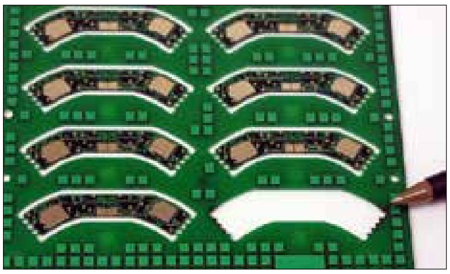
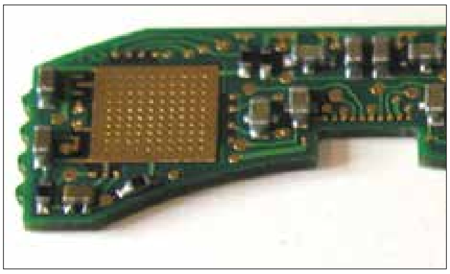
Cutting PCB (continued)





A 20-up board ready for separation. (below) Close up of part of a detached board.

The customer request for this application was to verify the feasibility of degating, or trimming, individual multi-layer PCBs from the parent board. Boards are held in place by four trim points on each end with the trim points measuring 0.775 mm thick by 0.635 mm wide. The laser cutting set-up comprised a Firestar f400 laser mounted behind an XY gantry with 90° "flying optics" delivering the beam down to the focusing optic in our cutting head. A 63.5 mm positive meniscus lens was chosen with a 1.8 mm depth of focus based on the required spot size and board thickness. In addition, a supply of 4.1 bars of air was provided as a gas assist to blow vaporized FR4 through the cut kerf.

To assist the customer in determining the right laser solution for his budget and throughput requirements, tests were performed using both 200 and 400 W of power. At the 200-W power level, the FR4 trim points were cut through at a speed of 3.2 m/min. Using 400 W the PCBs were cut out at 6.4 m/ min. In both cases, cut edges exhibit a small amount of FR4 charring; too small to be readily noticeable or affect the PCB in any way.

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Case Study

Young & Wood keep up to speed with customer demand

For more than 60 years engineering subcontractor Young & Wood of Harlow, Essex, has manufactured a diverse range of components for architectural fittings, commercial buses and the banking industry. The company has recently installed a Syncrono laser cutting machine from Prima Industrie in order to keep production costs down and remain competitive.

"Versatility is a key requirement for us in providing solutions for customers," explains director John O'Rourke. "In the morning we could be producing bus components, and in the afternoon, banking trolleys. It was vital we invested in a machine that was not only able to handle the wide-ranging job specifications, but also offered speed, reliability and the highest cutting quality."

Young & Wood uses a range of materials between 1 mm and 15 mm thick in its production processes – including mild steels, stainless and aluminium – and as such, was looking to source a machine that could cut both heavy and light gauge material to the standards required.

Six years ago the company added a Platino laser cutter from Prima to its machine set up – the majority of which are punching machines. Young & Wood typically profiled up to 15 mm thick mild steel, 8 mm stainless steel and 6 mm aluminium sheet on the Platino, which provides 0.03 mm cutting accuracy across its 3 x 1.5 m machining envelope. Superior dynamics enable a head speed of up to 140 m/min and acceleration of 12 m/s^2 to be achieved.

"The Platino's ability to pierce material in around 0.5 sec and cut at up to 6.5 m/ min has substantially reduced cycle times and increased our productivity, enabling us to minimise the effects of escalating raw material costs," explains John. "The machine's accuracy and repeatability has allowed us to manufacture a much wider range of products than is possible with our punching machine set up."

Impressed with the Platino's versatility and the high level of support and back-up from Prima, John decided to exchange it for a Syncrono in order to benefit from the further improvements to productivity and efficiency that it offered.

"Prima has always responded quickly when we have needed assistance and that is so important for us," he continues. "We had a few teething problems to overcome – which is to be expected with a piece of kit newly introduced to the market."

The Syncrono produces very fast processing times, enabling more than 1000 holes to be cut in one minute. While a job carried out on the punching machines typically took around 14 seconds to complete, Young & Wood has been able to achieve the same operation on the Syncrono in just 4 seconds (with N_2) and 6 seconds (with air).

A major benefit for the company is the Syncrono's adjustable optics, which provide fast speeds and extreme precision, irrespective of the gauge of metal being machined.

"This feature really sold it to us in view of the wide range of materials and thicknesses we deal with every day," concludes John. "Syncrono's modular construction and versatility ensures we can machine all of our jobs with confidence and have the flexibility to meet future production requirements.

"We currently utilise a shuttle table, which, at the end of the day shift, automatically switches over two plates. This is sufficient to feed the machine to enable 'lights out' operation. However, we plan to install Prima's automatic Compact Server stacker/destacker in the near future. Controlled directly by the Syncrono, this will enable us to handle an increased volume of work overnight."

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Case Study

Savekers invest in high speed laser tube cutting

A £655,000 investment in two state-of-the-art CNC laser cutting machines from Trumpf at the Birmingham facility of Savekers, an OEM that supplies its innovative range of architectural metalwork items to a host of industries, has introduced benefits that include an impressive reduction in average cycle times of 50-60% .

Savekers is a £4 million business employing 50 staff. Its architectural metalwork range includes: sliding door and window track products; cabinets and fittings; balustrades and handrails; door furniture and window guards; and disability products. Manufactured largely from tube, plate and sheet steel, all production operations with the exception of powder coating are conducted on-site at the firm's 45,000 sq ft factory. Typically the company sells its products to shopfitters, building merchants and construction firms as well as working with architects for specification on projects.

"The market is very tight at the moment, as it is everywhere, which is why our new Trumpf investments are so important," explains company Chairman Martin Saveker. "The new machines help us compete with higher end imports from competitors based in low cost economies and to take advantage of other factors such as inflation in the Far East, a weakening pound, 12-16 week lead-times and the rising cost of oil for transportation. It all means that many potential customers are looking to source from the UK once again."

Until recently Savekers had no laser cutting facility for tube and relied on an ageing waterjet profiling machine for its plate work. Mr Saveker knew things had to change. "We had to improve productivity, which basically meant generating greater speed to make us more cost-competitive in order to address new markets," he says. "We began by enquiring about a new tube laser as this would have the most significant impact on our business."

Fortunately the company was successful in securing a £90,000 SFIE (Selective Finance for Investment in England) grant from regional development agency Advantage West Midlands.

Phil Langford, Grants Case Officer at Advantage West Midlands, says: "Savekers identified two laser cutting machines that would enable it to significantly reduce the batch element of the production process. The machines also speed up operations, providing additional capabilities the company previously didn't have."

Savekers commenced its search by comparing the Trumpf TruLaser Tube 5000 with its main competitor, soon concluding that the flexibility of the former machine would be a huge advantage.

"While some batches are high, it is fairly common for us to do 1-off jobs," said Mr Saveker. "Sure enough the machine has a bundle feeder, but the ability to interrupt long runs and manually load small volumes is invaluable to our business."

For laser cutting tubes and profiles, the Trumpf TruLaser Tube 5000 is a flexible, automatic, complete machining system. It can process tube up to 6500 mm in length with wall thickness up to 6.4 mm (mild steel). The machine is available with loading unit and part removal station.

"Whereas we previously bought pre-slotted tube we can now manufacture slots of the desired length and in the exact position required by each customer," says Mr Saveker. "Previously we had to offer 'universal' versions of our slotted tubular products."

Mr Saveker says that speed was the major consideration behind seeking new flat bed profiling capability. Having already decided to buy the Trumpf TruLaser Tube 5000, it made sense to talk to the same supplier about a flat bed partner machine. The preferred model soon emerged as the Trumpf TruLaser 2525.

"We can cut at 200 mm/min using our existing waterjet facility, however the TruLaser 2525 can profile at 20,000 mm/ min for some jobs," says Mr Saveker.

The Trumpf TruLaser 2525 can cut

up 20 mm thick mild steel, 15 mm stainless steel and 10 mm aluminium. Typical Trumpf innovation is applied in the form of an additional Y-axis integrated in the motion unit. Unlike the standard Y axis, it does not move the complete motion unit, only the cutting head. The intelligent application of a double axis greatly increases the dynamics and reaction time of the machine and, particularly on small part geometry, processing time can be reduced by up to 30%.

"The second Y-axis works well for us because most of our details are small," states Mr Saveker.

The majority of the flat material processed by Savekers is 1-6mm thick and because of the high finish demands of its customers (no oxide can be present on the cut edge), both the TruLaser 2525 and TruLaser Tube 5000 are run using nitrogen from Savekers' in-house generating plant. However, in the near future the company is planning to add oxygen capability to allow it to process brass and thicker mild steel.

"Our new Trumpf machines have had a huge impact on our company," states Mr Saveker. "They form an integral part of a major business review, where we have examined our existing product range, stock and customer base.

"We've been static at £4 million turnover for the past 2-3 years but now we are looking to expand. The trend in recent years has been towards low volume, high value work, but this is now reversing and we're going after volume jobs that were previously imported. As part of installing our new Trumpf machines we've had a major shop floor reorganisation so that we are better able to handle larger batches."

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Case Study

Added flexibility and major cost savings for Mec-a-Tec

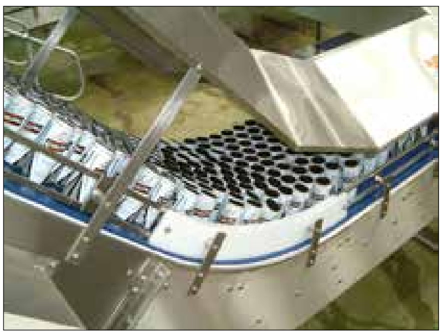
When orders for its specialist conveyor systems went up by 100% in a year, Wisbech-based Mec-a-Tec Services found that it was subcontracting out more and more laser profiling. By investing in an LVD Orion 3015 Plus 4 kW laser cutting machine it not only brought control over the work back in house, it also achieved an almost immediate payback on its investment.

Mec-a-Tec is the only UK company to manufacture and supply a complete range of bespoke conveying equipment for beer and beverage can-making and filling plants – with around 70% of its production being exported to all parts of the world.

Like all of the can-making industry, the company went through a lean time in the late 1990s as supermarkets switched away from cans to other packaging methods. In the past three or four years though, demand has accelerated rapidly as market sentiment has changed and new markets have opened up in Eastern Europe and Asia. The company now has a full order book and is one of the most active suppliers to the two-piece can-making sector.

Thousands of different components go into each job and, as every line is tailor-made, the elements each line have to be designed and manufactured for that specific project.

Lead times are generally tight too. The process equipment tends to be ordered well in advance, but the conveyors are the last piece in the jigsaw. The supplier knows all the elements that need to go into the line and orders them first because they are on long lead times, then the supplier starts to piece together the layout and how it will fit in the available space – only when that is complete will the conveyors be ordered.


Coors line

Paul Framingham, Mec-a-Tec's Technical Director, says, "The strong market over the past three or four years has put a lot of pressure to succeed on the business – with increasingly technical projects and ever shorter turnaround times. The most important thing to our customers when they buy from us is that they have confidence that we can perform to the needs of the project. Technical ability combined with speedy deliveries are of the utmost importance – but budgets are always tight and costs have to be reduced wherever possible.

"The main justification for the investment in the LVD machine was the amount of time and money being directed into subcontract laser cutting, while ever decreasing lead times on projects requiring a lot of original design reduce the amount of time available for manufacture.

"Our punch press is ten years old, and it was the latest technology when we bought it. But technology has moved on since then and the punch press just couldn't cope with the volume of work that we were doing, so we subcontracted it out. And as our turnover escalated we weren't just using one subcontractor, we were using two or three."

"The move to laser cutting meant that there was no need for deburring or cleaning of components and also improved accuracy. It was also more practical than finding a subcontractor with the right tooling to punch out each job. But using subcontractors on this scale took a lot of time and effort to manage, adding another layer of cost on top of the actual processing.

"Drawings would be emailed, quotations received, purchase orders raised, materials delivered, goods collected and then sorted before folding on our press brake. We believe that the actual costs of having the parts subcontracted out was about 40 to 50% higher than the actual invoiced values. For around £100,000 a year of invoices we probably had £140,000 of real cost – so you look at that and realise that the payback on the LVD Orion was going to be almost instant.

"Since the LVD Orion 3015 Plus Laser was installed in October 2007 we have also seen a dramatic reduction in the amount of time spent by our stores personnel organising purchase orders, deliveries of sheet and collection and sorting of subcontracted parts. We have also reduced the amount of time that accounts spend reconciling delivery notes to purchase orders and invoices. Component design will undoubtedly change too as the machine allows greater manufacturing possibilities over conventional methods."

As Mec-a-Tec's Managing Director Ian Claxton explains, "We aren't subcontractors so we weren't concerned about having a fast, high-volume machine that would be working 24 hours a day, and the Orion provided exactly what we needed. I dare say we could have spent another £100,000 and got a machine that was twice as fast, but we didn't need that. It is there for us to use to improve our business, decrease our lead times and increase our flexibility.

"The factors that are most important to us are production flexibility and time. When you are relying on another company you are in their hands when it comes to deliveries, and having a machine here gives us the flexibility we need. If something happens that needs turning round very quickly, then this machine can do it.

"We had to cope with a 100% increase in turnover from one year to the next and that was very difficult. Now we have the flexibility to increase it further – and we are saving £140,000 a year on subcontracting."

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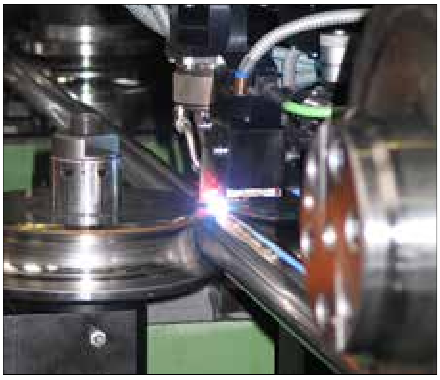
Rofin lasers in tube manufacture – a well rounded process

Steel tubes are today used to produce a vast array of products including water pipelines, steel furniture, machine frames and even fine tubes of less than 200 µm in diameter are used within the medical device industry. The fact is that thousands of miles of pipelines, tubes and profiles are formed, welded, cut and marked every day.

In many cases, the machines used for this diverse range of applications have lasers at the heart of the process, and with a complete range of laser sources and solutions available, Rofin are becoming involved in an increasing number of applications.

Laser welding – quick and reliable
The advantages of laser welding are well known to Esta Rohr, a manufacturing company in Siegen, Germany. Esta Rohr produce longitudinal seam welded, stainless steel pipes on a 3 shift operation using a 4.5 kW CO_2 Slab laser integrated within a Rofin Profile Welding System (PWS).



Laser welding of tubes using Rofin PWS

"The benefits for us are obvious", says Sven Pitzer, technical manager of Esta Rohr. "The laser is three times faster than the traditional TIG-welding process, and it is not the laser power that restricts the speed, but the subsequent in line annealing unit".

Another important factor for Esta Roht is the capability of the Profile Welding System to weld both austentitic and ferritic stainless steels. When manufacturing stainless steel tubes, the process benefits of the laser allow precise control of the laser parameters and therefore the energy used to create the weld, along the full length of the tube.

Esta Rohr is not only convinced by the process benefits of laser welding. The

Laser welded tubes bear up under high loads

laser also offers distinct advantages when it comes to system availability: The laser by comparison, has an availability of almost 100 % whereas with the traditional TIG-welding process electrodes have to be replaced regularly, causing the inevitable breaks in production .

In addition to Esta, more than twenty other companies worldwide have decided in favour of Rofin's CO_2 Slab lasers combined with the Profile Welding System for the manufacture of stainless steel tubes. With its integrated gap recognition the PWS sensor technology adjusts for even the smallest deviation of the weld seam position, and therefore optimum welding results are possible even under difficult conditions. As well as speed, laser weld seams are clearly more resilient than conventionally created weld seams which is a distinct advantage when tubes are to be formed and manipulated following the welding process.

Laser cutting - through thick and thin
The benefits of speed and precision are also apparent in the laser cutting and profiling of tubes. In instances where traditional methods such as drilling, milling, sawing or die cutting reach their limits, laser cutting opens up new possibilities.

All of the traditional methods of cutting and machining tubes generate mechanical loads which in turn can induce stresses into the materials and parts being processed. Laser cutting on the other hand is a contact free and highly flexible process. Simple programme changes enable different parts and profiles to be produced without the need to perform any tool changing operations. The thermal load on components which are cut using lasers is also minimal as demonstrated by Rofin's StarCut Tube system, which is used to manufacture miniature and intricate components such as 200 µm diameter medical Stents precisely and accurately in under 60 seconds.

The laser cutting process is not restricted to small and thin section parts. Large parts can be cut reliably and quickly by the laser, whether it is simple web cuts or very complex notch and contour cuts, the laser makes short work of the process. Thanks to the excellent quality of laser cut edges, there is often little or no further work required on the part, thus reducing component production times.

Quick to spot the benefits which could be obtained from lasers for processing of tubes and flat sheet, Alessandro Falconeri, founder and owner of the Italian company Dimensione Laser, has been using laser processing for more than ten years, with five tube cutting systems each using a Rofin CO_2 Slab laser. In this ever changing environment, the benefits of the laser are clear with simple programme changes, ultimate flexibility and high uptimes ensuring the maximum output.

Falconeri is convinced of the benefits which he obtains from his Rofin lasers. The compact and low maintenance features of the Rofin Slab Lasers are not the only important factors for Falconeri. Equally important is the high up-time and minimal gas consumption.

Laser marking – permanent and clear
The flexibility of the laser makes it the ideal solution to marking applications on steel tubes. Marking is used for quality control and part traceability. Rofin has developed a concept which enables tubes to be marked "on the fly" and with this system integrated to the tube production line, the system can be used to mark - part numbers, production dates and times, bar codes, data-matrix codes and even ascending or descending serial numbers. The laser marking process is not affected by surface impurities such as the thin film of oil which may be present form the tube forming process.

Whether the task is welding, cutting or marking of the smallest micron-precision device, production of large tubes or the generation of complex contours, Rofin lasers are used by many companies as a reliable, flexible and efficient solution to the application.

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MEMBERS' NEWS

Next generation TruLaser cell series 7000 with new performance package

A highlight of the "Powering Innovation" theme of Trumpf's EuroBLECH 2008 trade show presentation is the TruLaser Cell Series 7000. The next generation TruLaser Cell Series 7000 offers faster processing times, shorter positioning times and more flexibility. Mass producers with high production cycles as well as job shoppers can benefit from the radically overhauled laser system mechanics and software for 2D and 3D processing.

High speed cutting for shorter unit times
The TruLaser Cell Series 7000 now features higher dynamics. Optimal, smooth runs, higher operating speed and faster acceleration of the system significantly reduces processing times and therefore the costs of each manufactured part. Additionally, the optimized piercing strategy for thin metal sheet processing and the increased positioning speed reduce downtimes.

The user has more options to reduce production costs per part with the new generation TruLaser Cell Series 7000: standard laser technology tables for welding for up to 7 kilowatts or tables for high speed cutting with a laser output of up to 6 kilowatts, which allows cutting speeds up to 40 m/sec.

Smaller die diameter
Further savings in cost of production arise from a lower flow rate and process gas consumption resulting from a reduced die diameter. And for applications in which quality is secondary to the cost per part, the user may also cut parts with pressurized air.

Shorter positioning times
The graphical editor of the TruLaser Cell Series 7000 is entirely new. The integration of a TopsViewer allows the NC track to be visualized on the user screen. The user can thereby adapt the processing program comfortably and quickly, reducing the positioning times of new parts.

New modules and moveable partition
The TruLaser Cell Series 7000 offers a higher level of flexibility. Two new round axis modules for small and medium-sized rotation of symmetrical components are able to process a broader range of parts. Because the partition is flexible, the user can divide the work area asymmetrically and can load and unload large parts simultaneously during prime time.

Easier start-up for laser welding
Starting this spring, the new "WeldLine" is making the daily welding job significantly easier. Users of the TruLaser Cell Series 7000 can choose from three different packages for laser welding. With the base package, WeldLine Basic, and through the use of tables, the user can save and comfortably retrieve all required laser parameters. WeldLine Comfort controls up to four laser and gas mixtures. The proportional valve of the TruLaser Cell Series 7000 can now be easily switched from one welding job to the next. This saves time and increases security during the exchange between individual welding applications.

The WeldLine Professional application supports users who do not have extensive experience with laser welding, through a combination of technological know-how and the WeldLine Basic and WeldLine Comfort applications. WeldLine Professional includes laser technology tables with predefined parameter sets for mild steel and stainless steel.

Monitoring sensors protect optical path
The new LensLine lens monitoring sensors prevent the destruction of a soiled focusing lens. They protect the optical path from a potential soiling and protect the equipment from unnecessary down times.

With the TruLaser Cell 7000 series, Trumpf is setting new standards in the field of 3D laser processing. The modern laser cells offer more flexibility in all areas of application. From Aluminium to ultra stainless steel, in 2D or 3D, the TruLaser Cell 7000 series can weld, cut and finish surfaces efficiently.

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Laser Welding Pyrex Pipettes

This before (right) and after (left) photo shows the sealed spherical end

Pyrex® is a tough, durable, low-expansion borosilicate glass widely used in the manufacture of pipettes, flasks, and other Pyrex glassware found in laboratories throughout the world.

A unique application called for sealing Pyrex glass pipettes by welding one end. A Synrad sealed CO_2 lasers was used.

The glass welding set-up consisted of a rotary stage suspended beneath a gas jet manifold affixed to the laser faceplate. The manifold held a 63.5 mm positive-meniscus focusing lens that provides a 100 µm spot with a 1.8 mm depth of field. A gas jet fitting below the optic provided a connection for the assist gas, which in this case was 0.07 bar of clean, dry air.

Each pipette had an outside diameter of 2.1 mm with a wall thickness of 0.25 mm and was spun at 330 revolutions per minute by the rotary stage. After directing 50 watts of power at the end of the pipette for approximately 10 revolutions (1.8 seconds), perfectly welded spherical ends were achieved on the Pyrex pipettes.

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LIA Guide to Laser Cutting 2nd Edition Now Available!

This guide by AILU's John Powell is designed for all companies involved with laser cutting. The 2nd Edition has been updated and expanded in response to rapid advancements in laser equipment and techniques.

In addition to amended cutting tables and guides, it addresses ancillary issues such as purchasing decisions on laser cutting equipment.

Purchase from Laser Institute of America for $49 or pre-order at AILU for UK despatch.

Case Study

ATM Automation cuts through Polypipe's flash problem

As a highly respected systems solution provider to the plastics industry, ATM has been involved in many diverse and challenging applications. However, when Polypipe asked ATM to devise an automated solution for the removal of flash from their range of blow moulded Ridgigully products, ATM were presented with a highly unusual combination of design, process and Health & Safety challenges.

Polypipe Civils is the UK's leading manufacturer of surface water drainage, sewerage, cable protection systems and water management solutions, serving the utilities, construction, civil engineering, agricultural and sports and leisure markets. As part of the Polypipe surface water drainage system, Ridgigully products are blow moulded in HDPE (High-density polyethylene) in 3 different sizes. The post moulded products incorporate

significant amounts of flash around the mould joint line, which traditionally has been removed manually. The largest of these parts weighs up to 12 kg and with some areas of flash being up to 12 mm thick, so as a manual process this was both time consuming and arduous.

Following a review of various flash removal processes and automation concepts by Polypipe, ATM were chosen to provide a fully automated flash removal system based upon a six axis robot and a laser. This laser - robot is not in itself new, and ATM already had previous experience of building systems of this type for automotive industry customers. Automotive laser cutting applications, by their very nature, are fine tolerance, and whilst this demands precise programming and robot path control, the fact that the components have clearly defined datum points means that the laser and robot together can easily meet the dimensional and profile tolerances required. The major differences between this and the Polypipe application include the larger tolerance band of the blow moulded part and the material from which the part is produced.

Meeting the challenges

With three different sizes of product to be laser cut (300 mm, 750 mm and 900 mm) and a requirement to not only remove flash from the moulding but also to cut two 360 degree paths, ATM determined that the optimum solution would be for the robot to hold the part and manipulate it under a fixed laser cutting head. A six axis robot system with a horizontal reach of 2 m and a payload capacity of 50 kg, was chosen to provide the working range and handling capacity required for these large components.

ATM chose Rofin-Baasel UK Limited as the supplier of the laser system, based upon their extensive application experience and the excellent reputation for reliability of Rofin CO_2 lasers. A diffusion cooled slab laser with an output power of 2.5 kW was selected for the project. Detailed consideration also had to be given to fume extraction and filtration for this project: the parts being cut are produced from 100% regrind material and can contain a number of contaminants which could have a detrimental impact on the performance of any extraction and filtration system. Following a series of trials, a multi stage dosing filter system was developed, with the air extracted from the cell being dosed with Calcium Carbonate before reaching the filtration system. To minimise the time associated with cleaning filters and removing debris from the filtration system, two sets of filters were incorporated. This enables one set of filters to perform a self cleaning cycle, depositing any dust and debris in a bin, whilst the system continues to run using the second set of filters.

The work-cell incorporates two component fixtures at the operator load and un-load station. This enables the robot to deposit a completed part and immediately pick up a new part. With an internal safety door closed to protect the operator, the finished part can be manually removed and another part loaded for processing by the robot. The robot gripper system and the component location fixtures incorporate quick change tooling features to enable the system to handle the three different product sizes produced within the cell.

Focused on success

The Ridgigully components required flash to be removed from around the mould tool joint line, and in places this flash can be up to 12 mm thick. In addition, to enable the flash being removed to be re-processed more easily, the larger areas of waste material had to be cut into smaller pieces. This required intricate programming by the ATM engineers to achieve the balance between reducing the size of the waste material and maintaining target cycle time.

The major issue yet to be overcome in this application was the need to produce trimmed components with a minimum of excess material, on components that have potentially large part to part variations in size. The variation on each component meant that it was not possible to establish a consistent datum position, from which programme offsets could be generated.

ATM's solution was to use the laser "out of focus": more laser power would be required because of the larger spot size, making ATM's initial choice of a 2.5 kW laser a major contributing factor in developing this final solution. The larger spot size together with the higher power from the laser enabled the system to not only achieve the cut profiles required during flash removal, but to generate a sufficiently high temperatures during the trimming operation to partially melt the cut area, thereby providing a smooth aesthetic finish on the part.

Polypipe has achieved their objectives of turning a labour intensive and arduous task into a cost effective and highly reliable automated solution. ATM has also clearly demonstrated that difficult and unusual automation applications can become a reality using a combination of field proven hardware lateral thinking, and a determination to satisfy the customer's requirements..

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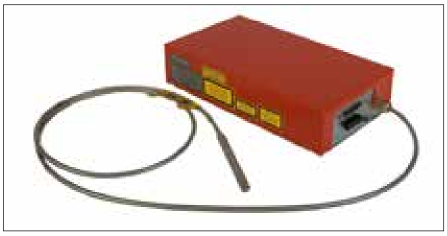
MEMBERS' NEWS

Drilling, marking, engraving

SPI products compete with traditional marking lasers



SPI Lasers' latest pulsed product, a 30 W fibre laser, is aimed at faster and higher quality marking, engraving and ablation applications. The laser has a typical M^2 of 3.2. This makes the laser more suitable for applications where a more "top hat" distribution is preferable to the lower order Gaussian mode e.g. where wider mark tacks and large area fills are required. Applications that can benefit from this laser source include: anneal marking, anodised aluminium marking, thin film patterning, plastic marking, engraving and paint removal.

The additional energy of the laser means that it is well suited to use in dual head marking stations giving >10 W per head. Utilizing SPI's successful G3 platform, the 30 W laser benefits from the flexibility in frequency range from CW to 500 kHz and the characteristic waveforms which allow user selectable pulses. The 30 W laser comes with both 2 m and 5 m beam delivery fibre options and is an extremely flexible option for manufacturers looking to reduce maintenance costs, reduce footprint of manufacturing processes and ultimately reduce cost of ownership.

Jack Gabzdyl, Product Line Manager for Pulsed Fibre Lasers, welcomed the release; "Beams from lasers with low order modes have a high central intensity; they can be defocused but the intensity issue remains. Developing a laser with flatter energy distribution enables greater and more varied materials processing -ablation, marking and engraving. Faster processing, higher production with crisper cleaner marks and for thin film applications in particular, less risk of damage to substrate."

A proof of concept and 'try before you buy' program can be found by clicking on the SPI web site at www.spilasers.com and registering your details on the 'Try before you buy' page.

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CombiLine advanced a solid laser marking platform from Rofin

The new CombiLine Advanced, an all purpose laser marking workstation, is Rofin's latest innovation in standard systems to suit a wide range of applications and industries.

The CombiLine Advanced is a robust and stable laser workstation designed for production of small and medium batch sizes. The system is available in two different configurations (WT) and (RT). The WT variant incorporates a static work table with a load capacity of up to 100 kg that can accommodate a work piece up to 760 mm x 500 mm x 600 mm.

The RT variant is supplied with a fully integrated 800 mm diameter rotary table with a load capacity of 10 kg on each side. A component can be laser marked on one side of the table whilst the other side of the table can be unloaded and re-loaded. This concept not only saves cycle time but also provides easy access for loading and unloading. The rotary table index time is an impressive 1.2 seconds, thus ensuring the maximum productivity from the system.

The CombiLine Advanced offers 300 mm of travel for the laser head and beam deflection unit. The WT variant is supplied with linear motion stages in 3 axes (X, Y & Z) whilst the RT variant has 2 axes (X & Z). Additional linear and rotary axes are available. With a wide choice of laser sources available from Rofin's extensive range, the system can be configured for a broad range of applications and materials.

Designed with a small footprint to minimise floor space requirements, and with its extremely robust construction, the CombiLine Advanced is capable of producing high quality laser marks repeatably within an industrial environment.

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Synrad marking applications

Laser marking silicone rubber keypads

Silicone rubber or elastomeric, keypads are being introduced in a variety of devices in consumer, medical, industrial, and automotive markets, replacing keypads and keyboards based on mechanical switches.

Marking by ablating a pre-inked coating

This marking demonstration was achieved using a Synrad 10 W CO_2 laser. The scanning head was fitted with a 200 mm focusing lens that provides a 290 µm diameter spot with a 5 mm depth of focus.

The "Power" legend was marked using 10 W at a rate of 2 m/s using two passes. The total cycle time for the operation was 0.77 sec.

Laser marking silicone tubing

Silicone tubing is widely used in the pharmaceutical and biotechnology industries where ultra-pure fluid transfer is essential for health and safety. In addition to its flexibility and puncture-resistance, silicone tubing is free of additives that could leach into, or contaminate, fluids carried by the tubing.

Marking 35 characters/s with 25 W of laser power

Using 25 W from a Synrad CO_2 laser at a velocity of 0.5 m/s a string of 30 characters was marked in a cycle time of 0.68 seconds.

Marking nylon electrical connectors

Nylon 6,6 (Polyamide) is a commonly used type of cast nylon found in a variety of automotive, industrial, and consumer products. It possesses excellent heat and chemical resistance and offers superior mechanical strength.

Marking 20 characters/s with 10 W of laser power

The injection-moulded electrical connectors in this example were produced from nylon 6,6 containing a 30% glass fill. A 10 W Synrad CO_2 laser was used and the scanning head provided a 180 µm focused spot.

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Interlinked printing machine, laser marking system and robot from Tampoprint®

Tampoprint has introduced an interlinked process consisting of a standard tampon printing machine and laser marking system integrated with a 6-axes robot for the feeding of the parts.

In the arrangement shown below the part holding trays are filled in advance with screwdrivers. These are then marked with a product identification code using an Alfalas® SK 32, a UV laser ideally suited for marking of the red plastic screwdriver grips. In the second step a Hybrid 90-2 tampon printing unit, a flexible 2-colour tampon printer that incorporates an integrated laser engraving unit for the production of the Cliché plates. By automating the process in this way the errors produced by operators can be completely eliminated.


Integrated marking and printing machine

With a logo diameter of order 85 mm approximately 215 images can be accommodated in the Hybrid 90-2 without having to change the cliché.

The machine is being exhibited at INTERPLAS 2008 in the NEC Birmingham.

<u>The Alfalas® “WST“ laser workstation</u>
Tampoprint's new Alfalas® “WST“ laser marking workstation is the ideal table-top solution. The unit is equipped with a 20 W diode pumped laser.

The unit can be used for marking a wide range of materials up to a height of 100 mm. This is an “all-in-one“ solution: there are no additional components such as external cooling units or power supply packs to accommodate.

It's range of applications includes metallic surfaces and plastics, straight and flat components, flexible and standard markings, even to the point of pixel graphics for the production of 4C clichés. To achieve more marking freedom the optional NC controlled rotary axis can be integrated without difficulty.


The new Alfalas WST laser marking workstation

The Alfalas® WST“ is a low-priced solution for laboratories, workshops and offices. It is equipped with a technology comparable to that of a measuring machine, which permanently guarantees a co-parallelism of objective to work surface to produce high quality markings.

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Case Study

Fabricating challenges using multi-axis laser machining

LAI International is a supplier of precision components and sub-assemblies for original equipment manufacturers, operating from several facilities across the USA. For more than three decades, Eric Nelson, vice president and chief technology officer, LAI international, has stayed committed to Laserdyne laser systems.

Rich Technology International is a diversified contract manufacturer and one of the five LAI International, Inc. manufacturing facilities dedicated to supplying of precision engineered components and assemblies for the aircraft, power generation and defence industries.

A typical job – spacer bands for land-based turbines – requires laser cutting a series of accurately spaced complex profiles along the part contour. Part runs for this job average 40 to 50 sets a week using one of the refurbished Laserdyne 890 BeamDirector systems equipped with a 3 kW CO_2 laser, see figure 1. The material is 440 stainless steel with a chrome additive - a very hard material that processes efficiently on the system with consistently smooth, burr-free edges. Accuracies are a tight 100 μm true position total tolerance for the special airfoil shape and speeds are relatively fast considering the geometry of the part features, reports Mr. Nelson.

"Achieving this level of productivity and accuracies from one job to another is possible because of how Laserdyne designs and integrates its system features," reports Mr. Nelson. "Everything works perfectly together – the controller, software, motors, laser – because everything is Laserdyne designed and manufactured."

Figure 1. Complex hole shapes are laser cut with 100 μm accuracy and high repeatability.

A perfect example is Laserdyne's Automatic Focus Control (AFC™). It's a feature Mr. Nelson swears by and one with which he provided Laserdyne feedback and saw refined through the years. AFC guides the motion system, maintaining focus position and following the part contour regardless of surface irregularities. With AFC, all machine axes react to sensing of the part surface, creating unlimited R-axis correction with high speed and unmatched sensitivity. AFC allows top machine speeds so productivity is maximized without downtime or scrapped parts.

LAI International uses trepanning, percussion drilling, and drill on the fly laser processing techniques in which the AFC feature is extremely important. For trepanning, Laserdyne's laser positioning systems allows for unique and tight tolerance trepanned features such as those shown in figure 2.

Figure 2. LAI International uses trepanning laser drilling process to produce hundreds of precision shaped cooling holes in aerospace combustor components.

A variation of percussion drilling is "drill-on-the fly" where pulses are delivered to the part by the stationary laser while the part is rotated. The hole placement is a function of rotational speed and laser pulse frequency. If multiple pulses are required, "drill-on-the-fly", software developed by Laserdyne engineers, is utilized to synchronize the movement of the part to the laser pulses, ensuring that multiple pulses are delivered to the exact location required. By changing the laser pulse energy, pulse count or lens focal length, the characteristics of the drilled hole size and taper can be controlled to meet the requirements of the part. Drill-on-the-fly software also allows changes of the pulse shape during the process to improve hole geometry.

"System repeatability (±2.5 μm) of the machine really comes into play on our jobs," Mr. Nelson reports. Our Laserdyne 890 and 780 BeamDirectors with their Automatic Focus Control features are designed so we maintain

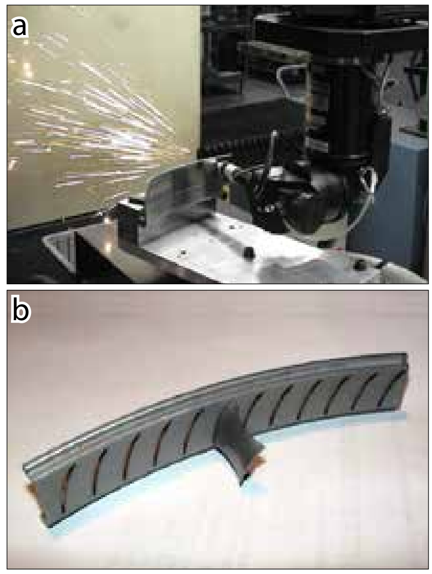

Figure 3 (a) Laser drilling of an Inconel aircraft vane component; (b) the finished part. Part features are accurate to 100 μm true position

extremely good accuracy with consistency through the entire work envelope."

With equipment options that include waterjet and EDM, Mr. Nelson's equipment preference for laser drilling aircraft vane sector components is a Laserdyne system with a BeamDirector because it provides higher feed rates and is more accurate, he reports.

In the job shown in figures 3, the Inconel part sets up quickly. Multi-axis laser machining is essentially a non-contact process so only minimal clamping is required. Using an updated Laserdyne 780 BeamDirector equipped with a 1500 Watt CO2 laser, 1500 to 2000 of these parts are laser processed at LAI, week after week, with only minimal operator adjustments.

"The multi-axis laser stands out as a very unique manufacturing system in today's broad array of fabricating systems," reports Mr. Nelson. "Getting the most out of a machine is one thing. Getting the most out of an entire manufacturing technology is something else. And it is much more challenging today because part features, hole configuration and size, material difficulty, speed and quality required have exceeded anything thought possible even just a few years ago, let alone when this all began in the mid-1980's. With Laserdyne, we're meeting those challenges and more."

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Case Study

Lasers bear fruit for cherry corporation

Since the company's incorporation by Walter L. Cherry in 1953, Cherry Electrical Corporation has grown to become a household name around the world for its range of innovative electrical products.

Cherry's European production began in 1964 in Auerbach, Germany. Today, the plant has 1,400 employees involved in the development and production of micro-switches, keyboards, components for the automobile industry, and controls for household appliances. Subsidiaries in Germany the Czech Republic, employ a further 700 personnel.

The success of the company can also be measured by a number of accolades awarded to the organisation in Auerbach. These include: Automotive Lean Production Award 2006, Best European Factory 2005. A key to this success lies in the company's philosophy to embrace new technology wherever possible. This can be demonstrated most effectively in the development of new manufacturing methods; for example, in the early use of laser technology.

<u>Lasers Revolutionise Keyboard Marking</u>
Cherry started manufacturing computer keyboards in the 1980's and had quickly become the world market leader. The individual keys however, originally injection-moulded in two colours, proved to be too expensive for the emerging mass PC market.

In an effort to reduce manufacturing costs, the sublimation labelling method was introduced. This process, however, brought its own problems due to the ever increasing number of country and function variants, prompting a search for a more flexible and cost effective way of labelling the keyboard keys. It was during this review that the Rofin and Cherry relationship blossomed.

Laser marked keyboard

Using the correct parameters, Nd:YAG lasers generate a high-contrast marking through a colour change in the material on a number of plastics. In contrast to printing, laser marking is indelible and anti-abrasive, even in cases of intensive use. The laser beam scanner heads can provide every conceivable option of form and marking content. However, the target cycle time together with the size of the marking area, was initially a problem for Cherry. The processing area of a scanner head only covered half the width of the keyboard and mechanical repositioning of the keyboard or laser head was not possible due to the short 20 second time available for each marking cycle.

<u>Rofin's Definitive Solution</u>
Rofin suggested a solution based upon a laser, a beam splitter, and two deflection heads. The beam splitter would guide the laser beam through the scanner heads sequentially. Each head would then mark half the keyboard in turn, within ten seconds.

The prototype system delivered by Rofin fulfilled all expectations. Cherry then further optimized the composition of the plastics used in the manufacturing process to obtain the best possible marking results, and became one of the first suppliers to the world market able to offer the new, flexible, high-quality marking method for keyboards.

<u>Today up to 3 lasers work simultaneously</u>
Today at Cherry, up to three lasers mark a keyboard at once - two at the top and one at the bottom. In this way, the complicated adhesion of a label to the bottom of the keyboard is no longer necessary. If desired, monochrome manufacturer logos or text can also be generated at the same time. If necessary, the complete marking procedure can be completed in less than 5 seconds.

On some of its five assembly lines, the company is producing value-added keyboards incorporating integrated barcode or chip card readers and fingerprint or RFID sensors. Such requirements are becoming increasingly common.

<u>Complex Mechatronics for the Automotive Industry</u>
The Automotive division at Cherry in Auerbach is now the main revenue-generating division of the company, accounting for 60% of all income. Over the years, Cherry has systematically

Keyboard marking using Rofin lasers

developed into one of the leading Tier 2 suppliers for complex modules used for switching and control. The product range extends from locking systems, switches and controls for the inside of vehicles, shift gates, immobilizers, to electrical ignition locks or components for adaptive chassis control.

Once again, Cherry's commitment to innovation has proven to be key in its success within the automotive market. Cherry's corporate culture motivates employees with its ideas for new and better production methods. The automotive industry makes great use of lasers for marking and traceability. Bar codes, ID and serial numbers are the perfect method for tracking the progress of each component through the various process steps during manufacture, with traceability for each component an essential part of the process.

In this case, the Rofin lasers generates unique and individual markings which can withstand the harsh conditions found in automotive applications.

<u>Ongoing Success Based On Constant Development</u>
Cherry's strive for innovation has resulted in its production lines being continuously updated or redesigned. As a result of this process, the entire spectrum of automated manufacturing technology is in evidence on the production lines, industrial robots, feeding systems, solder baths, cable assembly, and so on.

If new marking solutions must be developed, which take internal know-how to the limits, Rofin's laser specialists and their application laboratory are ready to evaluate new methods at short notice. Ongoing and intensive cooperation with the laser manufacturer is one of the factors that lets Cherry meet its future challenges with confidence.

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Better micro-machining results with pulsed ultraviolet lasers

The need for miniaturization and better edge quality are pushing solid-state 355 nm nanosecond lasers to their limits. Comparing the new MATRIX UV with longer pulse and 266 nm lasers yields surprising results.

It is well known that material removal with pulsed laser beams results from a combination of thermal processing and photoablation. Infrared and visible lasers predominantly rely on thermal processing thereby potentially giving rise to a heat affected zone (HAZ) in which there may be unwanted effects such as charring, melting, cracking and the deposition of re-cast material. On the other hand, the superior micromachining results achieved using pulsed UV lasers are due to their high photon energy and the fact that most materials show higher absorption towards shorter wavelengths i.e. UV photons don't penetrate as deeply into the processed material, resulting in higher power densities and causing photoablation, with better material removal.

The width of the laser pulses is also important. As a rule, the longer the pulse, the more likely a material is to suffer thermal effects, even with a UV wavelength. Also, the minimum size of a focused laser spot decreases with better beam quality a shorter wavelength.

<u>Short pulse, high beam quality UV for cold processing and better spatial resolution</u>

It follows from the above that the key to producing smaller features and clean edges with focused laser beams, even in delicate and thin materials, is to limit thermal effects by using a laser that produces short wavelengths and short pulses with high beam quality.

For several years this need has been satisfied by lasers with an output wavelength of 355 nm and a typical pulse duration of 50-150 nanoseconds. But where there is a need to produce holes and slots smaller than say 10 microns, or to produce clean cuts without the need for post-processing, such lasers are not always the optimum choice.

The new MATRIX UV from Coherent delivers 10-20 ns pulses at output powers up to 2 W with near diffraction limited beam quality, showing excellent results in micromachining such as small features and clean cuts, such as in the manufacture of medical components.

A recent comparison of the MATRIX UV with longer pulse 355 nm and 266 nm lasers has demonstrated that the micromachining results of the MATRIX UV in many materials are comparable to those obtained with more costly 266 nm lasers and superior to those produced by longer pulse sources. More specifically, when cutting a stainless steel foil, the results with the MATRIX UV were found to be almost as good as with a 266 nm source as can be seen in figure 1. The high thermal conductivity of metals negates some of the short-pulse effects, but for most metal foil applications the MATRIX UV remains the best choice.

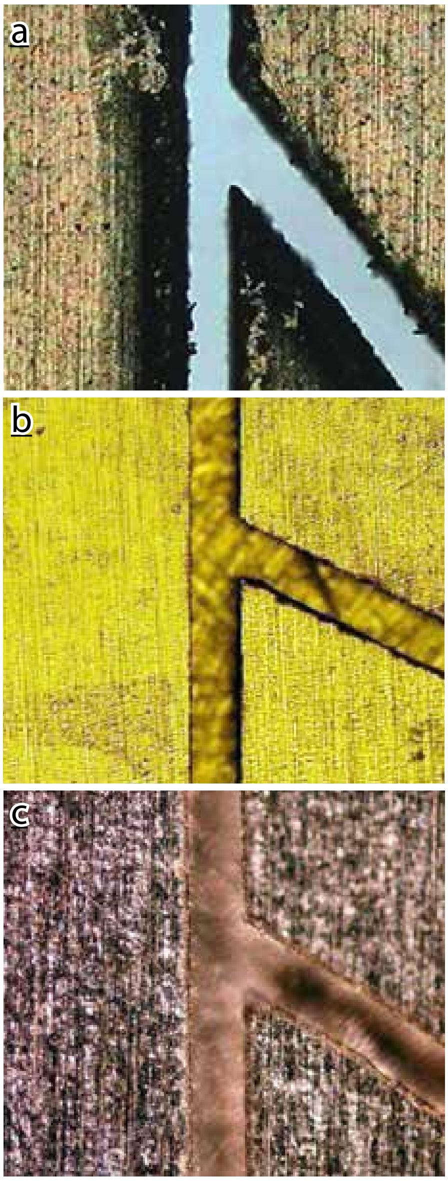

Fig 1. Thin stainless steel and most other metals can be quickly cut using UV lasers, the choice of which depends on the required cut quality. (a) 355 nm long pulse laser, (b) 266 nm laser, and (c) 355 short pulse laser (MATRIX UV)

The new Matrix UV offers better micromachining

With Kapton® and Mylar® samples that have been micro-machined with the MATRIX UV, and with a longer pulse 355 nm laser and a 266 nm laser, the results were indistinguishable. Teflon with coloured additives absorbs less strongly, but the short pulse 355 nm laser can still deliver almost the same results as the 266 nm laser. The lower cost and higher throughput of the short pulse 355 nm MATRIX UV means that it remains the laser of choice.

Ceramics respond very well to 355 nm laser light. The shorter pulse length can improve processing conditions, when compared to longer pulse sources.

Finally, most glass materials (except for coloured glasses) do not strongly absorb at 355 nm. Consequently, these materials are best machined at shorter wavelengths and for this reason a 266 nm laser has a clear advantage over one at 355 nm for glass processing. An even better solution may be to use a picosecond laser, such as the Paladin or the new Talisker from Coherent, which are both available with high power outputs.

<u>Conclusion</u>

Short-pulsed, high beam quality 355 nm lasers enable improved results in many applications without increasing unit costs. To determine the best processing strategy, it is advisable to partner with a laser manufacturer with a broad portfolio of products, such as Coherent, who can test samples to establish an optimum processing strategy.

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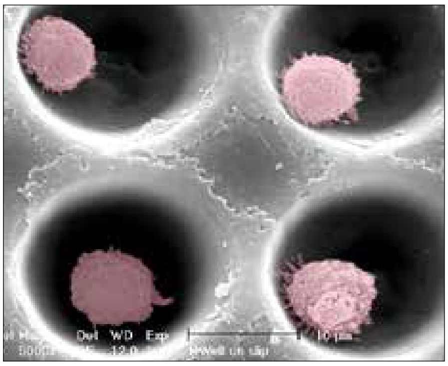
Job Shops

MetaFAB become first UK commercial 157 nm laser machining service

High-resolution precision micro-engineering of Fluoropolymers, Fused Silica, Quartz, Sapphire, Teflon AF and PEEK is now possible thanks to unique service.

The first UK commercial service for Laser Micromachining at 157 nm has been launched. This service enables companies, around the world, to fabricate microscale features with a high-resolution (Ra ~2nm) finish in parts made from materials that are traditionally difficult to machine.

These materials include Fluoropolymers (PTFE, Teflon AF), Fused silica, Quartz, Sapphire, PEEK and others; materials used for industrial microfluidic, instrumentation, biochip, medical, microreactor and photonic products, where resilient or UV-transmissive materials are needed.



S.E.M. of four KG1a acute myloid leukemia cells resting in 157 nm laser machined microwells

The Xtreme Laser Facility service has opened at the metaFAB micro- & nano-engineering innovation and technology transfer enterprise within Cardiff University School of Engineering.

The facility also accommodates high-power, high-resolution equipment for creating miniature and micro-scale structures in literally any material ranging from biopolymers to diamond. This new open-access industry facility uses an extremely short-pulse, femtosecond laser which does not cause any significant thermal heating to the materials machined.

Features sizes of ~2µm are possible in 'any' material. Industries as diverse as instrumentation, tooling, MEMS and medical implants are finding that their products can be differentiated by exploiting this new capability.

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Synchron Laser Service develop fibre laser ceramic scribing

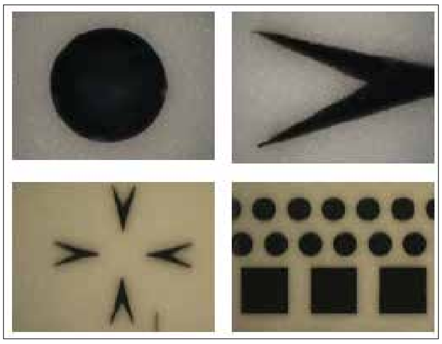
Fibre lasers are proving to be a disruptive enabling technology in the scribing, drilling and cutting of ceramic substrates in an industry still predominantly using flowing CO_2 laser technology developed in the 1970's.

Synchron Laser Services, a job shop and turn-key OEM based in South Lyon, Michigan USA have developed a process capability to replace 500 W CO_2 lasers with 200 W fibre lasers for high precision machining of ceramic substrates.

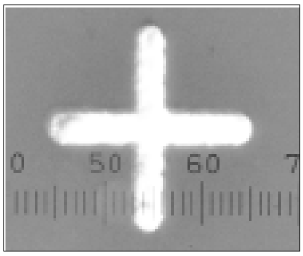
'Synchron's process is the first major improvement in accuracy and precision combined with very high throughput in laser scribing of ceramics since, well, since laser scribing was first commercialized in the early 70's,' said Rich Budd, founder of Synchron Laser Services.

Synchron's patent-pending fibre laser process, which makes use of the high brightness and small spot size of the focused beam of the fibre laser together with the use of an easily removable proprietary coating, is the key enabling technology for high speed manufacturing to the tight tolerances for the placement of guide holes for LED lens orientation and for circuit via holes required by the components for these high density displays. An additional benefit arises from the cost reduction allowed by size (volume) reduction for gold filled circuit via holes.

An example of a high tolerance application is in the rapidly growing market for LED video screens. Having made an impact in the outdoor advertising and entertainment display market over the past few years, the number of full colour indoor displays being installed in shopping centres, supermarkets, convention centres, airports, railway stations and sports arenas to entertain, market products or provide useful information to the public is increasing significantly. Moreover, the trend in the indoor display industry is moving towards smaller screen sizes which in turn require a smaller pixel pitch for better screen resolution and higher contrast.

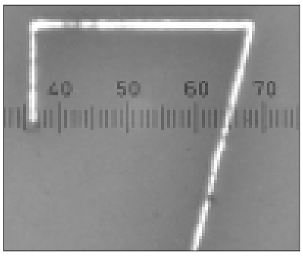


Ceramic substrates machined with an SPI 200 W fibre laser



Ceramic substrates illustrating high precision machining

Alignment fiducial in 380 µm thick alumina



Machine ID number showing very narrow kerf

In both photos the scale division is 0.001"

Displays which are viewed at close distances require high brightness, high contrast and low heat dissipation to avoid the need for cooling fans. Mounting the LEDs on ceramic substrates provides the heat sinking capabilities that enable the LEDs to be driven at the high drive currents required to achieve this performance.

Another application for precision high temperature ceramic substrates is the automotive electronics sector where, as the number and complexity of on-board electronics systems increases, size and thermal management become critical considerations.

Synchron's fibre laser based machining capability addresses directly a need in many areas of the ceramics substrate industry for a new technology to replace ageing systems that are increasingly difficult and costly to maintain. The advantages of the fibre laser including low heat affected zone (HAZ) and high position and machining tolerances together with the significant cost of ownership savings both in terms of overall energy efficiency and maintenance costs compared to those of flowing CO_2 lasers make a compelling business proposition.

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Microkerf purchases Trumpf laser
Leicester-based laser cutting subcontractor Microkerf has ordered a new TruLaser 5030 CNC laser profiling centre from Trumpf complete with single head technology and a 5 kW TruFlow laser.

ISO9001-accredited Microkerf has established a strong reputation for diversity of service since its formation in 1990. "It's true that the work we undertake is extremely varied," said the company's Managing Director David Gattward. "I would say that if we are not number one in the country for diversity, then we are certainly in the top three."

With so many jobs featuring different material thickness, the need to keep laser cutting head changes to an absolute minimum is paramount. "At present we have to organise our production so that we cut all of our urgent thin jobs, followed by all of our urgent thicker work," explained David. "However, it does make things difficult when we are trying to work with short lead-times."

At present, Microkerf can limit its cutting head changes to twice a day, each of which takes approximately 20 minutes to complete, equating to approximately 175 hours of lost production time per year. The new Trumpf TruLaser 5030 will help Microkerf regain these lost hours, thanks to Trumpf single head technology featuring automatic nozzle changes.

In a recent trial 20 jobs were processed with a large variety of parts and materials: the use of the new nozzle changer saved more than 60 minutes of handling and waiting time. The carrier plate of the changer can hold up to eight nozzles arranged according to job requirements. During the exchange process the laser head and swing arm of the nozzle changer assume the transfer position, before the rotary clamp chuck of the swivel arm removes the nozzle and relocates it on the carrier arm. A new nozzle is retrieved and inserted into the cutting head ready for the next job.

"We opted for the TruLaser 5030 because of its improved processes, higher dynamics and shorter non-productive times," concluded David. "It will enable us to achieve even faster and better processing, and will certainly provide an edge over the competition."

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Second Bystronic 6 kW laser for Precision Profiles
18 months after commissioning the UK's first 6 kW Bystronic Bystar 3015 laser cutting system, Precision Profiles Laser Division has placed an order for a second similar system, but with a bed size of 4 x 2.5 m. The order is valued at in excess of £500,000.

Precision Profiles, part of a £28 M group of companies, was established in its present form in 1987 to provide a profiling, plasma, laser cutting and steel stockholding facility. This was closely followed with fasteners, tools and stainless steel stockholding divisions. The company invested in its first Bystronic laser in 2002 and this was followed by a second machine in 2003. Both these machines feature 3.5 kW resonators and are used to produce a wide range of components for a variety of customers including those in the yellow goods, architectural and bridge building industries.

The company identified an opportunity to further increase the service it provides by moving into the 20 – 25 mm material thickness market resulting in the purchase of the first 6 kW system.

Chris Southworth, the company's material manager, said "When we took the decision to invest in the 6 kW laser the natural choice was Bystronic. We visited the manufacturing unit in Switzerland where a number of samples were cut. A specific job for the agricultural industry, which we cannot cut on our existing machines, produced such amazing results that the subsequent machining and drilling operations were eliminated.

"We have become a market leader in the cutting of thicker materials and the machine has opened up new markets, particularly in aluminium.

"One of our earlier Bystronic systems is due to be replaced and we made the decision to again look at a 6 kW machine. We have limited factory space and therefore a machine equipped with an automatic handling system is not a viable option. To counteract this we felt going for a larger bed size would allow us to have more 2500 mm x 1250 mm plates on the bed at any one time, thus reducing machining down time and making us even more efficient and productive."

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SSC investment tops £2 M mark
SSC Laser (formerly Steel Service Centre) has placed an order with Bystronic UK Limited for equipment valued at in excess of £350,000 for a Bystronic Byspeed laser cutting system equipped with 4.4 kW resonator. It is the sixth Bystronic laser (and the third Byspeed) to be purchased by the company since 2000 and represents an overall investment of over £2M. SSC Laser is undergoing an expansion programme and this latest machine will be sited at a new site in Peterlee, County Durham.

Austin Jarrett, managing director of SCC Laser (left) opens negotiations with Lawrence Cairns and Dave Larcombe of Bystronic UK Limited

Austin Jarrett, SSC Laser's managing director, comments: "When we surveyed our customers to find out their impressions and views on SSC Laser and three overwhelming points were made: they like doing business with us as we are friendly and professional, we offer fast delivery times, and we are local."

"Their views on locality encouraged us to set up new locations throughout the country. Peterlee will be the first of the locations to open."

Mr Jarrett concludes: "Traditionally laser cutting has been most suited to material thickness of 6 mm and above. However, the Byspeed is capable of cutting thin materials very quickly – something which is very pertinent to punching technology. We have been able to attract those customers who were using punching technology and they are now reaping the benefits of laser cutting. Because of this, when it came to investing in equipment for the new SSC Laser site, we were never in any doubt that the Byspeed laser cutting system was the most suitable option for us and we opened negotiations with Bystronic at the recent MACH exhibition."

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Tube laser contributes to Hydram Sheet Metalwork's world class strategy

In the past two years Hydram Sheet Metalwork has invested more than £2 million in capital equipment and plans to expand its factory by a further 2800 m^2 next year. A crucial part of this investment has been the installation of a BLM CNC tube bender and, more recently, a BLM Adige LT 712D CNC tube laser.

With over 30 years' experience in subcontract manufacturing, Hydram has built a reputation for high quality sheet metal components, assemblies and light fabrications produced at its 6500 m^2 factory.

"The marketplace is becoming increasingly competitive, with UK companies looking to offshore manufacture or dual source as a way of combating increases in energy, material and labour costs," says John Young, Managing Director. "To counter this trend we are investing in more efficient and productive equipment while, at the same time, looking further afield for customers within the UK and continental Europe. Tube bending is one of our core competencies and we needed to upgrade our capability in terms of automated operation. The tube laser, has opened up new market opportunities while differentiating Hydram from its competitors."

The decision to purchase the LT 712D tube laser was based in part on the performance and reliability of the BLM Dynamo CNC tube bender and the new machine's 8.5 metre tube length processing capacity. "We were also impressed by the build quality of the machine, its off-line programming capability, the service and support provided by BLM and the experiences of other end-users," said David Greatorex, Operations Director. "Where we would previously have used several machines to process tubular components, we now use the tube laser and have eliminated inaccuracies and work-in-progress. It has also impacted on operations downstream, for example, by eliminating the need for welding jigs as parts can now be tagged. All of this has enabled us to take cost out of the job."

"We consider Hydram to be one of the top sheet metalworking companies in the UK, with more than 150 customers spread across virtually every industry sector," says David Greatorex. "However, the objective is to be confirmed as world class when assessed against the criteria typically used by 'blue chip' manufacturing companies such as Nissan.

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Safety

Lasermet wins laser safety contract at Manchester's Photon Science Institute

Lasermet has recently equipped Manchester's £40 M state-of-the-art Photon Science Institute with the latest in laser safety equipment.

Dr Mark Dickinson of the Institute said "With such a variety of lasers under one roof, safety considerations have obviously been paramount. We wanted the flexibility to re-configure experimental areas while still maintaining a high degree of safety. Lasermet offered us the most cost-effective all-round solution to our requirements. We have been delighted with the quality of their products and their professional installation service."

In the dedicated laboratories Lasermet installed full length heavy-duty laser-blocking curtains integrated with fixed interlock systems and beam shutters. For the open-plan spaces Lasermet supplied heavy-duty laser-blocking screens to connecting together to make up 4-sided enclosures. Portable versions of the Lasermet interlock system were supplied for ease-of-use with the enclosures.

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GSI Group

Interview with Philippe Brak

The new Vice President and General Manager of GSI Group's Laser Division, based in Rugby UK, responds to questions sent in by AILU members

What do you see are the strengths and weaknesses of GSI in relation to the other main laser manufacturers?

GSI Lasers' major strengths are its application and customer knowledge. Unlike other laser manufacturers, we are not simply building lasers, but lasers specifically designed to meet the needs of industrial manufacturing – complete with all software interfaces, as well as cutting and welding tools. It is difficult for our competitors to catch up with over 30 years of experience in this arena.

GSI seems to be doing very well in China, but how do you see the markets for your products growing in the EU over the next few years?

We see tremendous potential in the European markets. However, we have not focused there, mainly because of local German competition. We recently added sales and service resources in our German office to start concentrating on the European markets. When we compete head to head with our competitors we usually win. There is no reason why this cannot be done in Europe.

What are GSI's plans regarding product lines in high power solid state laser sources, including fibre lasers? In particular, have you got any plans to launch high power direct diode or picosecond laser products?

Our attention is currently on the development of high power (multi kilowatt) fibre lasers. This is a natural extension of our current product line. These lasers will over time replace our CW lamp pumped lasers, as well as some of our high power CO_2 lasers. Although our customer base is slow in adapting to the change over to fibre lasers, it will happen over time. We will need to have these products in place in order to serve our current and future customers; and thereby protect our market share.

In addition, we are presently looking into direct diode and short pulse systems. We recently launched a £1.2m collaborative research and development project in partnership with the LPA Group at Heriot-Watt University, PowerPhotonic Ltd., and Cranfield University, thanks to investment from the Technology Strategy Board. As lead partner in this High Efficiency Laser Processing Systems (HELPSYS) Project, GSI is aiming to develop fibre coupled diode laser sources with beam qualities good enough to be used in a broad range of mainstream applications. Specifically, this will include a significant increase in the efficiency of current laser based welding processes to the point where they are more efficient than our current technologies.

We do believe there is a significant market opportunity for short pulse systems as well, although they are not as far along in their development cycle. These laser systems are likely to play a bigger role in applications where very fine structures need to be addressed.

The UK laser community is very aware of the turmoil at the GSI Rugby plant over the past 10 years or more, especially since the merger of General Scanning and Lumonics. With your arrival in Rugby can the Rugby plant look forward to a period of relative stability?

I would not call it turmoil; there have been quite a few acquisitions and mergers, but very little focus. I want to bring focus to the organisation so we can be number one or two in the markets we elect to participate in. Currently, our main focus is in industrial manufacturing with lamp pumped solid state and fibre laser technology. Since my arrival in January, we have divested all of our gas laser products, except for our DC CO_2 line. This laser fits in nicely with the customers we currently serve, over 90% of which are located in Asia.

The GSI sales and service centre in Suzhou, China - key to GSI's success in Asia

Following GSI's recent purchase of Excel, how do you see Excel's products (Quantronix, Synrad, Continuum, Cambridge Tech, Custom Systemation etc) being integrated into the GSI portfolio and existing manufacturing bases. What impact (if any) will there be on the Rugby facility?

It is too early to tell, the deal has not closed yet. There is currently little or no overlap with the products we presently manufacture or sell out of Rugby, so little impact should be expected. Most of our products are complementary and in some cases, serve the same customers. In those cases, we can take advantage of the synergies in our sales and support organization.

Some of the Excel product range contains a number of "scientific" rather than industrial products, quite different from the current GSI product range (but similar to the old Lumonics product range which had scientific lasers). Does this represent a change in strategy for GSI or will the "scientific" parts of Excel be disposed of?

We are not really changing our strategy. In order to develop next generation applications and markets, it is important to be involved with the scientific community. All of the applications we serve today were developed 20 to 30 years ago in a lab. Any of the industrial or OEM markets all started at some time in the lab. Being an early adaptor and being involved early on at the development stage of these applications are crucial for future success.

continued over ...

Are there near term plans to increase the power available from your fibre laser source and how do you rate its performance compared to the competition?

We are currently evaluating initial versions of our 400 W fibre laser in the applications lab (processing results will be presented at ICALEO in October) which we expect to release for sale in Q4 this year. Our product release road-map takes us into the multi-kilowatt regime during 2009 – we are somewhat conservative with our product releases as we like to get the product right first time. Our key product advantages continue to be the integrated nature of our lasers where the product is easy to use for industrial applications – specifically cutting, welding and drilling. For instance, we are the only fibre laser company that supplies its own integrated process tools such as cutting and welding heads and galvanometer based scan-heads complete with integral GUI (Graphical User Interface) based software. This makes machine integration extremely simple.

How do you see the future for lamp-pumped Nd:YAG rod lasers?

There is a two-tier answer. The majority of the lasers we build today are pulsed. These lasers in most cases cannot be replaced by fibre lasers, not because they are currently not available, but because of the physics involved. The peak power of these lasers is so high that the light simply cannot be transmitted through fibre because of Stimulated Brillouin Scattering (SBS) - all the incoming light will basically be back reflected and not transmit through the fibre. I do believe that over the coming years most of the CW lamp pumped and diode pumped lasers will be replaced with fibre lasers. However, currently the lamp pumped lasers are still growing at a rate of 10 per cent per year. These lasers are very reliable work horses and are easy to fix when they break. Lamp changes are fast and inexpensive and are done mostly preventively. Therefore, the up-time of the production lines using these lasers is very high. Diode pumped lasers have proven to be very costly when they break down, with downtimes of several days. For these lasers, it is not the cost of the repair per se, it is the cost of the production line being down. Fibre lasers look very promising but still need to be proven.

How do you see industrial laser processing technology moving in the future; in particular with regard to applications for high brightness solid state laser sources?

We believe fibre lasers still have a long way to go to fully penetrate the market, especially at higher powers. Notwithstanding, that opportunity is very much present. Clearly, advances need to be made in understanding some of the material interactions, especially in thick-section cutting. Some considerable cost targets need to be met as well. Beyond that, diode technology, on its own, remains an untapped market, and if brought into the mainstream (by further solving the brightness issues) it could make significant changes to the industrial-processing landscape.

How do you think that the increased product servitisation of the manufacturing industry will affect the laser industry in general and GSI in particular?

Certainly at GSI we see our added-value isn't just in the product, but rather in the way we assist our customers in solving their problems. Our applications engineers work either in the applications lab or more and more now in the field with the customer. This is especially the case with some of our fast moving EMS (Electronics Manufacturing Services) customers in the Far East. They need to move rapidly as they change over from manufacturing one high volume product to another, driven by feature or fashion orientated product model changes.

In general applications terms the fibre laser is attractive for many applications because of its higher beam quality. How do you see the fibre laser competing with other DPSS sources for marking, welding and other key process areas?

Fibre lasers do not just have the advantage of better beam quality, their reliability, simplicity, compactness and efficiency are other important drivers of this technology. Fibre lasers will not be the solution to every application. It is not clear it will be possible to cut all material with fibre lasers. Some welding applications seem to go better with conventional lasers, for example. GSI is in an excellent position, having all technologies available, and thereby able to focus on providing customers with the best solution for their particular application, rather than pushing preferred technologies.

WELCOME TO NEW CORPORATE MEMBERS

Applied Sweepers

Beakbane Ltd

Birmingham Laser Cutting Ltd

Bisley Office Equipment

Boxford Ltd

Design and Manufacture Ltd

DMS Laser Profiles Ltd

High Speed Lasers Ltd

Hucknall Sheet Metal Engineering Ltd

Irepa Laser

JC Gillespie

optoSiC GmbH

Richards Sheet Metal Ltd

Research

CEMMNT's new website

The Centre of Excellence in Metrology for Micro and Nano Technologies (CEMMNT) has launched a new website (www.cemmnt.co.uk) providing comprehensive information for industry on metrology, surface analysis and systems engineering. The site includes details on cutting edge measurement and characterisation techniques (http://www.cemmnt.co.uk/techniques.php) highlighting their key capabilities.

Over 30 case study applications (http://www.cemmnt.co.uk/applications.php) underline the practical benefits of measurement and characterisation at the micro and nanoscale. Examples from design, development. Web pages focusing on different industry sectors (http://www.cemmnt.co.uk/industries.php) collate the key techniques and relevant applications that are commonly applied to accelerate product commercialisation.

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EDITORIAL

PRESIDENT'S MESSAGE

I hope everyone saw the first edition of the AILU e-newsletter, our latest industry communication venture. It is planned to be an important, regular and complementary service. It is dedicated to providing short news items and topical information quickly to laser users and those in associated fields. One of the AILU objectives of the e-newsletter is to raise our profile throughout the international laser community.

I would also like to mention that AILU is carrying out a study on behalf of the Photonics Knowledge Transfer Network (PKTN) entitled 'A Comprehensive Product and Process Review of the UK Laser Materials Processing Market with the Aim of Identifying Future R&D'. The objectives of this study include undertaking a review of the UK laser materials processing market and identifying future R&D opportunities in the UK laser materials processing market.

The project is being carried out in four phases and the first phase was completed at the end of July, leading to the production of a report on 'Top level UK Research in Laser Materials Processing' by Prof. Bill Steen and Dr John Powell. This draft report is available to all members of AILU on the members area of the website (in the resources library, under 'strategy'). It highlights the substantial effort and technical expertise in laser material processing available in the UK, though this is of course nowhere near matching the levels in some of our competitor countries such as Germany and the US. It is clear from the table of research activities against groups that the current hot research topic is rapid manufacture (or additive manufacture) and AILU is planning to hold a workshop to cover the developments in this exciting research area early in 2009.

For those of us in the laser processing research community this is a very exciting time and the results of the second phase of the project, to identify future research opportunities and needs, will be awaited with great interest. The work will be completed during October, with members being invited to contribute on the AILU web site. This process is of course vital to ensure that research is timely, relevant and focused. Equally important is to ensure that the outputs from the research find their way into UK industry. The last objective of the project will be to identify mechanisms for this. We certainly hope and expect that AILU will have a significant role in the process.

Stewart Williams

Most GORGEOUS PART

Janet Stoyel, owner/manager of The Cloth Clinic is winner of this quarter's Most Gorgeous Part.

"The photo is a Laserlace Shawl that I created specifically for the Metropolitam Museum of Art, New York," said Janet. "The textile curator asked if I would make an exclusive design for their museum to coincide with an exhibition entitled: Matisse and his Textiles. A visual of an artifact in the MET collection arrived in email format soon after. I designed around this black and white copy, producing 7 different design options.

"I was asked if I could produce in quantity - 100? Never having manufactured 100 of just one design I was interested in the order and not particularly worried about the quantity. The 100 pieces sold out at the private view evening - fantastic. The Met ordered more shawls in incremental quantities until suddenly I had produced 4,600 pieces - one of the Met's best sellers. As a result of this success this year I am once again a featured artist for the Met. All thanks to laser technology and artistic development!"

Thread of the month

Abridged from one of this quarter's threads on the AILU forum

Cutting holes for thread tapping
Posted by Martin Sharp
Liverpool John Moores University:
Is it possible to cut circular holes on a flatbed CO_2 laser system that can be tapped with a thread? If so what is the smallest diameter that could be considered in, say, 3 mm Stainless with O_2-assisted cutting?

Replied included:

Tom Mongan, Subcon Laser Cutting:
Laser cutting hardens the material edge so taps tend to wear out quickly. We usually cut tapped holes undersize to be opened out by drilling or reaming.

Neil Main, Micrometric, Lincoln:
1) N_2 cut stainless (and MS) tap better and with less wear than O_2 cut metal.

2) there are clear differences between taps. We use spiral groove machine taps and get reasonable life. The lubricant is also important.

3) Be careful of tolerances and specs. There are tables of thread fit that specify a centre for the thread form and a distance away from nominal. The tolerance on a laser cut hole for < 3 mm diameter may reduce the amount of metal and hence the quality of the thread. For thicker material cut quality and parallelism may cause thread quality and possibly tap binding problems.

Stephen Ainsworth
SJ Ainsworth Consultancy:
Avoid using O_2 for cutting holes that are to be post-processed, because the oxide layer is brittle.

For 3 mm material in the Auto Industry we drill small positioning holes and use Taptite or Ejots fasteners, both of which extrude the material to form a "nut" and cut a reuseable thread as the fastener is applied:no brittle edge issue, no cost of tapping, maximum number of threads to optimise clamp forces.

Where two or more layers of material (parts) are bolted together, we would cut clearance holes in the upper ones (oversize holes are used to take out tolerances in the build up - this gives the diameter of washer required), and only extrude the thread into the bottom material - so we would always encourage designers to specify the joint with the thickest material is at the bottom of

Job shop corner

Dave Connaway

As a job-shop owner, senior member of society and a saver, the financial debacle over the last few months has not given me many reasons to be optimistic. Yes, our turnover is up 10% over the same period as last year (Jan to Aug) but then mild steel prices have risen from £ 483/tonne to £ 780/tonne in the last 12 months. For prime 6 mm S275 plate we have paid in September £ 114 per sheet, yet this time last year we paid £ 70 per sheet. Our quarterly stock check has almost trebled but our turnover and profitability has not followed this upward trend and we do not have more stock, just more expensive stock. I recently reviewed our insurance and increased our stock figures from £40K to over £130K, adding £1000 per annum on our premium!

With ever more H&S issues to resolve, employment laws and EU directives in the Industrial sector we are scrutinised at every opportunity. Yet the financial institutions have seemingly managed to evade any controls whatsoever. In fact they have been de-regulated! Now the politicians are spending our hard earned cash to bail-out the same bankers who have at every opportunity charged businesses over the odds to place our meagre ~~bonuses~~ wages with them.

So what about our savings? In times of hardship and uncertainty I cut my costs. As a small job-shop I cannot expect the Government to bail me out if I make a mistake, unlike the financial institutions. What happens to our equipment either bought through a loan or in my case with 2 large operating leases? What if the institutions covering the loans decide to throw in the towel? Does that leave the laser job-shop without a laser? Testing times ahead and I have a feeling that the end will be sometime towards 2010 at the earliest. We have just felt a turnover downturn in this last week, having been very busy all year; thankfully I have had that "keep our costs down" strategy in place since January.

Enough gloom and doom! The new AILU web site is now fully functional and there is plenty of information to help you with new business and new ideas. The Medical Group have a one day meeting at Photonex 08 on 16th October and I have been actively looking at this sector for some time with a view to diversifying into the medical equipment market. The CO_2 market is very competitive and using the AILU seminars just might make a difference in these testing times. If not this event then you might like to consider the workshop on 3rd December on 'laser processing of polymer, metal and ceramic composites' at CAMTeC, Rotherham; again, an area that I have to admit is somewhat of a black art, so a day in Rotherham might just give you an edge over the opposition.

Sandwiched between these 2 events we have a cracking agenda for our annual Job Shop Business Meeting, arranged for Wednesday November 12th at the premises of Trumpf UK Ltd. We will discuss CO_2 cutting (Gerhard Hammann, Trumpf), automation, website optimisation, health and safety in the workplace and we will have some innovation presentations from (hopefully) steel, laser gas, optics and machine suppliers and what about those energy suppliers who keep increasing their prices?

Oh! Apparently I will be talking about the Job Shop Group constitution at the meeting so make sure you turn-up and have your tuppence worth of input. The JSG committee really would like your views on constitutional matters before decisions are made. Whilst at Trumpf there will be a chance to tour their machine showroom and as a Trumpf user I will be very interested in their latest offerings.

Now energy prices are my favourite gripe at the moment and the JSG surveys will be coming around again soon, so make sure you complete and send them to AILU. Past Chairman of the JSG, Neil Main, made a huge saving on laser gases 2 years ago just by knowing what everyone else was being charged and then negotiating down the prices his job shop would pay. In the current economic situation keeping those costs down is going to be significant.

Greatest Cock-up

In our early days when the company was small, we had but 4 staff: two directors, a sales-guy and a production manager/system setter/operator. The latter was a new employee having come highly recommended by the sales guy as being 'a YAG laser marking expert with many years experience'. He helped with setting-up the sub-con marking side of our business.

We were a fast growing business, with 1 laser and a number of demanding clients. Assured by his good start off we went on a business trip to Germany, leaving the sales guy and the 'YAG expert' to hold the fort for 2 days.

One day into the trip we get a frantic call: "The system is down! We have major production and immediate deadlines to meet," said the 'YAG Expert'. "I told you not to buy 'that laser' from 'that company'." I had no alternative but to call the supplier, who sent an 'emergency laser engineer' to fix the machine. The call-out cost was £380 and that was 13 years ago! When he got there he looked at the machine then turned the key to ON – machine now working!

Embarrassed by his mistake the 'YAG Expert' asked the 'emergency laser engineer' to do him a favour. To save his embarrassment could he please do a quick service on the machine to minimise the impact of the call-out cost? "No problem, mate", said the 'emergency laser engineer', who for some reason unknown to us today promptly grabbed one of the machine's cooling hoses and pulled it off.

As he had not switched-off the chiller or the power to the rest of the device a jet of water emerged that went straight in to the open casing of the laser and the PC, monitor, etc, causing appreciable damage to the machine and losing us all the files of our fledgling business.

The moral of the story is not to judge people by their job title. During the last 13 years I have met a lot of 'YAG Experts'!

Submitted by a sadder but wiser AILU job shop owner/manager.

Laser-assisted micro structure fabrication by using nano-particles

Qin Hu, PingAn Hu and Bill O'Neill

The miniaturization of components has been an enormously strong economic driver over the last 50 years. Current micro-engineering manufacturing methods employed for semiconductors allow complex multi-material systems that are created using planar methods of construction. Materials are often added in sequence with many process steps being required for exposing resists, depositing oxides or etching surface patterns. The results are quite spectacular: micro-systems manufacturers have provided the world with an incredible array of gadgets and high performance computer chips. The drawback to these manufacturing routes is not performance but cost. Huge economies of scale are needed for cost reduction which in turn means that typical Silicon fabrication plants can cost up $5 billion, with a very hefty operational budget. The entry costs are high and the associated technologies are not available to the wider manufacturing community which ultimately limits the number of manufacturing enterprises in this sector. In addition current micro-systems are very much built on planar landscapes, they are inherently 2D and only take advantage of the third dimension through via-holes that enable 2.5D interconnectivity.

The EPSRC 3D Mintegration Grand Challenge consortium (http://www.3d-mintegration.com/index.php), comprising the universities of Heriot Watt, Cranfield, Nottingham, Loughborough, Greenwich, Brunel, and Cambridge, and the National Physical Laboratory, are currently exploring new low cost manufacturing methodologies for 3D micro-systems technologies that can be produced by using printing, stamping, and other selective deposition techniques that offer low capital investment levels and can meet Moore's law resolution levels. If we are successful, next generation micro-systems could be manufactured in a totally new way and have enhanced attributes due to the 3D nature of their designs.

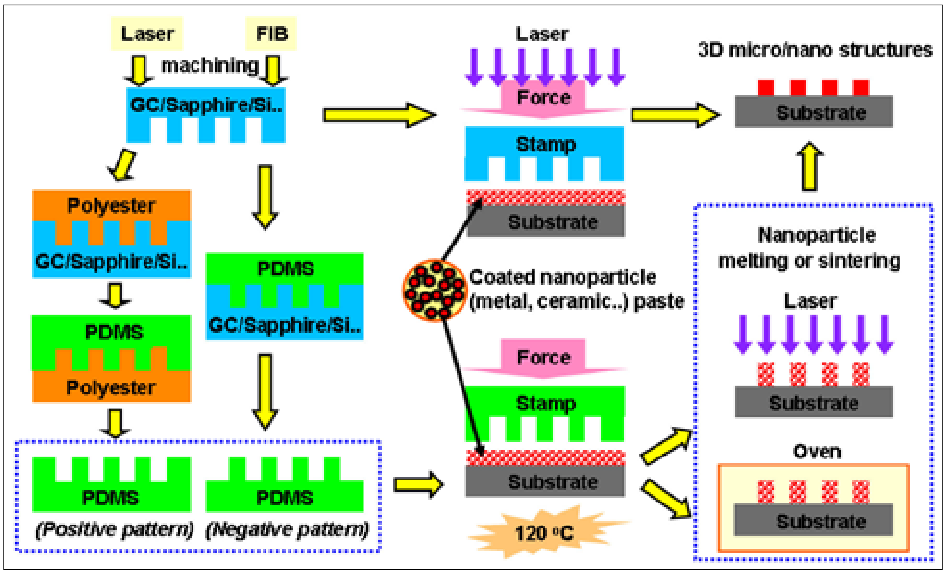


Figure 1. Schematic of Laser Print Forming (LPF) process

As one component of the research objectives, the Cambridge team has proposed the concept of Laser Print Forming (LPF) to overcome the cost and resolution limitations of conventional planar micro fabrication. LPF uses a combination of micro-tool making, printing techniques and laser consolidation combined with the wonderfully strange properties of nano particles, to create a flexible deposition and patterning technology. This process is a close relative of embossing with the use of tool-sets machined by Focused Ion Beam (FIB) or lasers, to pattern large areas of the target material in order to induce the necessary micro or even nano structural features.

Nanoparticles are used as building blocks because the melting temperatures of nano particles can be much lower than that of the bulk materials, due to the large ratio of surface atoms to inner atoms. For example, the melting temperature of iron particles in the range of a few nanometers lies approximately between 200~400 ^{O}C compared to 1538 ^{O}C for bulk iron. Processing energy can be greatly reduced, which can prolong the lifetime of tool-sets and minimize the damage to the surrounding areas, not withstanding the benefits of lower energy consumption during production. Also, by selecting the correct size distribution of multi-material deposits, it is possible to melt a layer of conducting, semi-conducting, and insulting material at a single temperature. By selecting suitable multilayer deposition strategies, it could be possible to grow completely assembled microsystems including the packaging elements and the interfaces necessary to link to the outside world. This would be a revolutionary step forward for micro-system production.

The concept of Laser Print Forming process is illustrated in figure 1. A tool-set directly machined by FIB or laser is brought into contact with a substrate with a layer of functional nanoparticle paste on the surface. The laser excites the particles and the stamp is pressed into the resulting paste layer. After solidification, the stamp is separated from the printed features and is immediately available for next print cycle. The tool-sets machined by FIB (Focused Ion Beam) or laser can also be easily replicated by PDMS (polydimethylsioxane) either positively or negatively; this PDMS replica can then be used as a stamp to print at low temperature to form the micro/nano features, which are made of nano parti-

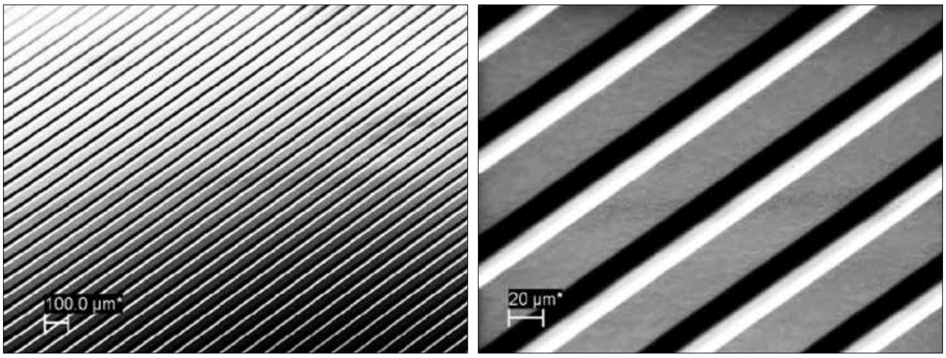


Figure 2. Trenches machined on glassy carbon by SPI G3.0 Yb Pulsed Fibre Laser

cles and organic solvents. After stamp removal, the laser is used to irradiate the printed structures, to evaporate the solvents, and melt or sinter the nano particles. This heating process can also be done in conventional low cost convective or radiative ovens. The key issues associated with this technique include tool fabrication, nano particle paste preparation and handling, laser melting/sintering, as well as system design considerations.

Besides the traditional tool materials like sapphire, silicon and nickel, we are also working on glassy carbon (GC), an advanced material of pure carbon combining glassy and ceramic properties. The service temperature can be as high as 3000 ^{O}C, which is suitable to print on almost all materials with the particle size range from nanometres to microns and even on bulk substrates. Glassy carbon also shows no wetting by many saline, metallic and ceramic melts. It's other super properties include high hardness and strength, extreme corrosion resistance, low thermal expansion, extreme resistance to thermal shock, good electrical conductivity and biocompatibility.

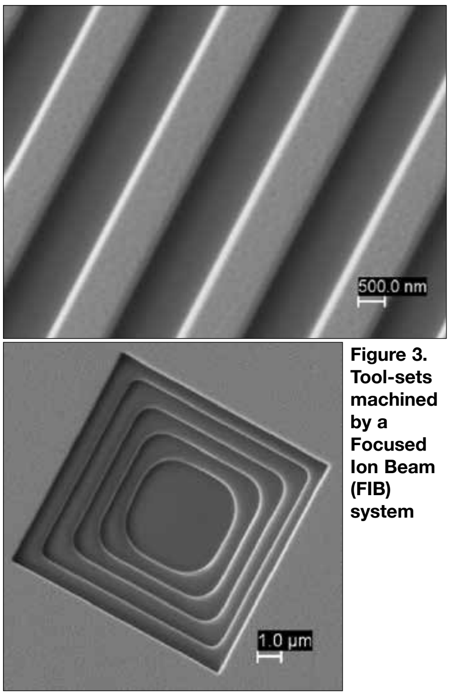


Figure 3. Tool-sets machined by a Focused Ion Beam (FIB) system

Two different routes have been used to fabricate the hard tool-sets – laser machining and FIB machining, depending on the size of the tool-sets and the required quality. For laser machining, we have been using a low cost fibre laser which is capable of delivering high quality tool-sets in glassy carbon and steels. Figure 2 shows the trenches machined on glassy carbon by a G3.0 Yb Pulsed Fibre Laser (SPI Photonics). The SEM images were taken after sample cleaning. Surface debris has been removed by laser cleaning at below the damage threshold.

We know that laser machining is suitable for making micro or even larger tool-sets in the centimetre range. For smaller or super high quality tools, we have used a Zeiss FIB system. The Zeiss 1540 CrossBeam FIB/SEM system has a reading resolution of just ~ 5 nm and a writing resolution of ~7 nm, which enables us to realise the highest quality tools. Figure 3 shows two examples.

FIB processing is much more expensive and time consuming than laser machining, so for large tool-sets we can combine both routes together - laser rough cutting followed by FIB fine polishing.

Once we get high quality hard tool-sets via laser/FIB machining, they can be further replicated by PDMS. PDMS is the most widely used silicon-based organic polymer. It is optically clear, non-toxic, and has high gas permeability, which allows evaporation of organic solvents during the heating treatment. Its surface can be chemically modified in order to obtain the interfacial properties of interest, e.g. change from hydrophobic to hydrophilic by simple oxygen plasma treatment. The conformal contact between the PDMS stamp and substrate can greatly reduce the residual layer during the printing process. Also due to its unique flexibility, it can print on non-planar surfaces. Negative replicas can be made by directly pouring PDMS pre-polymer on hard master tool-sets. After curing, the PDMS is peeled away from the master tool-sets, the resulting stamp is for use. Master tool-sets are also preserved and ready for reuse. Unlike silicon, no anti-stick coating is needed on glassy carbon tool-sets to replicate PDMS stamp. To get positive replica from master tool-sets, polyester resin is first replicated from master. Then PDMS is replicated from polyester tool-sets. So both positive and negative pattern are achievable. Figure 4 shows two examples.

One of the key components in the LPF process is the nano particle building block. We have tried both solvent and paste formats, fabricated in-house and sourced from commercial suppliers. This is the where the most sensitive intellectual property (IP) lies: most companies never patent their formulations, relying on in-house secrets to secure their IP.

Figure 5 (overleaf) shows copper nano particle patterns printed on a silicon wafer and silver nano particle double-layered printing on glass.

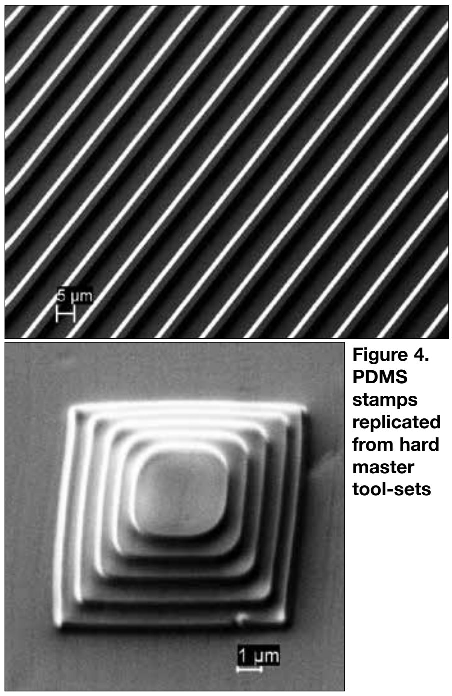
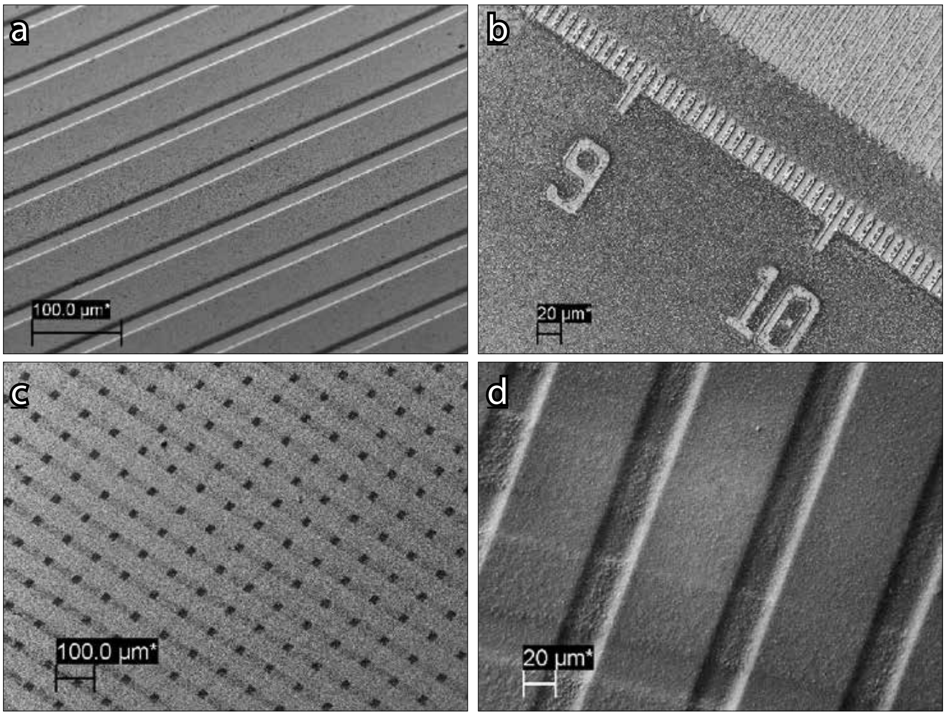


Figure 4. PDMS stamps replicated from hard master tool-sets



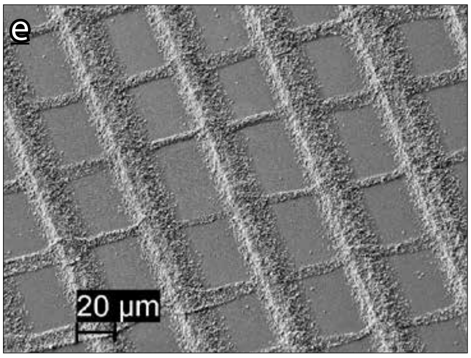


Figure 5. Nano particle pattern printing using a PDMS stamp.

(a) and (b) Copper nano particle printing on a silicon wafer.

(c), (d) and (e) Silver nano particle double-layered printing on glass

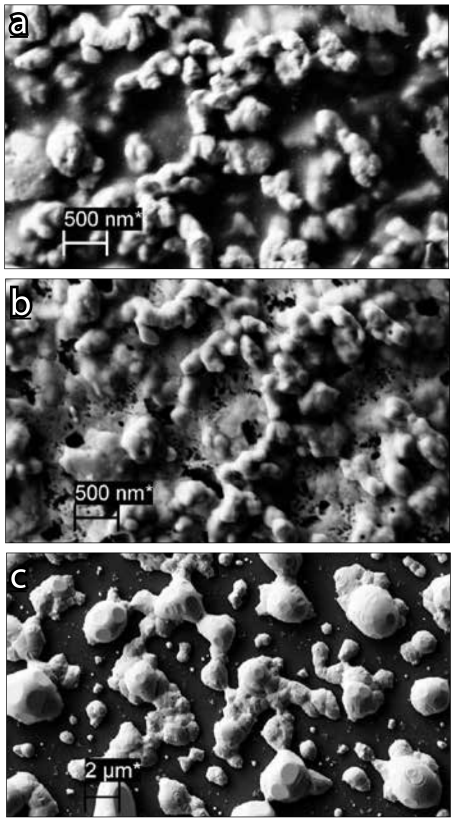


Figure 6. Silver nano particle paste sintered at (a) 200 ^{O}C, (b) 300 ^{O}C, and (c) 400 ^{O}C

The main problem of nano particle solvents is low particle concentration. The maximum achievable is about 10 wt% (above this, particles tend to precipitate). Such low concentration normally leads to high volume shrinkage during heat treatment. For this reason high-concentration paste format is preferred, which brings with it the problem of nano particle agglomeration. This brings another challenge: the synthesis of nano particle paste with particle sizes less then 50 nm. Most commercial nano particle pastes are focused on silver, but at relatively large particle size e.g. 200 nm.

For silver particles with size of ~ 200 nm, the sintering temperature of 300 ^{O}C is enough to consolidate silver particles and make the pattern conductive (see figure 6). When the temperature is further increased to 400 ^{O}C, particles begin to cluster and material continuity is lost.

At present we are trying to synthesize silver pastes with particle size less than 10 nm to further decrease the processing temperature. The sintering temperature of copper is much higher than silver, around 600 ^{O}C for 40 nm particles. Oxidation is another problem, and if not controlled the resulting conductivity is much less than the bulk. The rising cost of silver only increases the drive to replace silver by copper in printed electronics, which brings up another demand to synthesize proper copper nano particle paste. Silver coated copper paste may be a compromise; it has similar conductivity to silver but without the oxidation issues of copper. We are currently investigating nano particle sintering by pulsed laser methods instead of convective or radiative thermal techniques. Laser pulses can selectively heat nanoparticles without damaging the substrate or adjacent components.

The Laser Print Forming process requires further development. We are currently developing semiconducting nano particles in conjunction with metals and insulators. Application programmes are focusing on printed LEDs, micro three dimensional coordinate measuring machine probes, transistors, nano-wires, and micro fluidic elements. Our next step is to develop multi-material layered structures so that we can fabricate complex Micro-systems and integrate the “assembly” directly into the fabrication steps. By combining the merits of nano-technology, FIB processing and laser engineering, the LPF technique is targeted at nano-scale resolutions and a host of materials. We hope that this work will form the basis of 21st century micro-system fabrication technologies and perhaps it may even lead to personal gadget printing machine.

The authors are with the Centre for Industrial Photonics, Institute for Manufacturing, Department of Engineering, University of Cambridge

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Qin Hu gained a PhD in Physics from the University of Western Ontario (Canada) in 2003 and has worked in the Nanofabrication Laboratory in Canada. Since April 2006, Qin Hu has worked at Cambridge University on the £9-million funded 3D-Mintegration Grand Challenge project.

See Observations p55

Enhanced capabilities of laser welding by hybridization and combination techniques

Dirk Petring

The degrees of freedom and the process limits of laser welding are considerably enhanced in laser hybrid and combination welding techniques. The application of these techniques is illustrated below in two examples. The first is an example of hybrid welding and deals with single-pass laser-MAG hybrid welding of high-strength steel plates up to 30 mm thick, with large gap tolerances. The second addresses the manufacturing benefits of integrated cutting and welding using a multifunctional laser combi-head.

Enhanced Welding Capabilities by Hybrid Processing

CO_2 laser MAG hybrid welding is firmly established in the shipbuilding industry for joining metal plates of wall thickness up to 15 mm (see [1] and references therein). The example chosen is taken from the work of the recently completed European project HYBLAS, funded by the RFCS*. The goal was to develop process procedures for laser hybrid welding of structural steels with yield strengths of up to 690 MPa and wall thicknesses up to 30 mm. The Fraunhofer ILT led the work-package “process development and production of welds”.

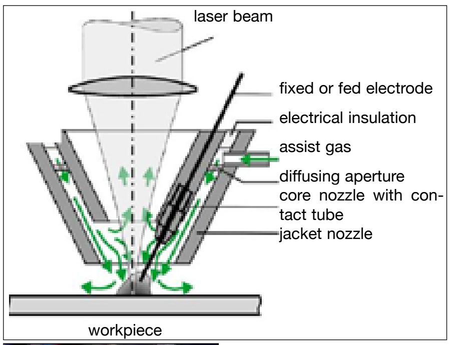
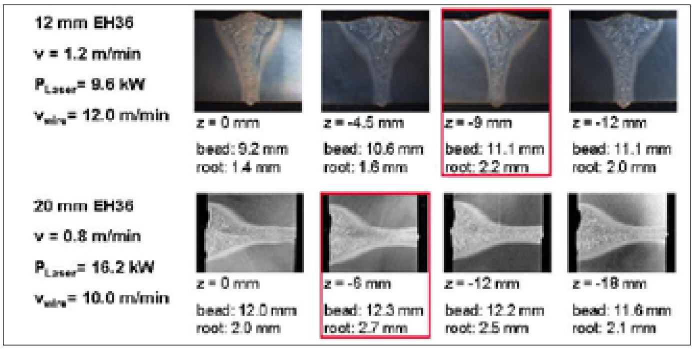


Figure 1. Sketch and practical set up of the integrated hybrid welding nozzle

* Research Fund for Coal and Steel

Most welds were carried out with the integrated hybrid welding nozzle developed by ILT, as shown in figure 1. The MAG power supply was a Fronius TPS450 programmable welding power source. The laser source used for the welds shown in this article was a Trumpf TLF 20000t CO_2 (20 kW) laser.

The integrated hybrid welding nozzle combines laser and arc in a single water cooled nozzle, with an integrated contact tube for contacting and stable guiding of the wire electrode. This design enables the closest proximity of laser and arc at the steepest arc inclination – thereby promoting the synergy of laser and arc. The nozzle provides a coaxial, homogeneous gas flow without contamination by air entrainment (Venturi effect). An Ar-He-O_2 mixture is used with the CO_2 laser.



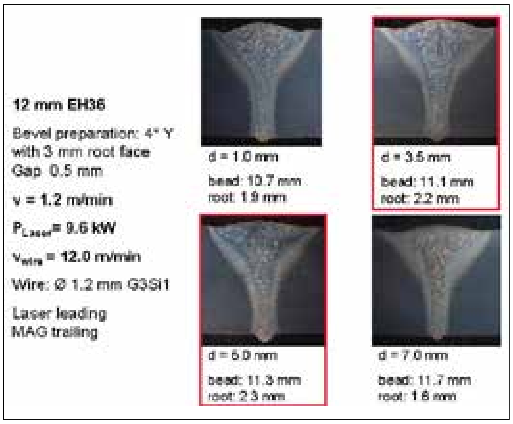


Figure 2. The wide parameter range of hybrid laser welding optimised for weld efficiency. Boxed conditions represent the most efficient welds.

(above) Variation of focal position within a plate.

(right) Variation of distance between laser and arc

Basic Parameter Configuration

As with any other welding process, the capabilities of laser-MAG hybrid welding are essentially determined by the appropriate selection of the system setup and the basic parameter configuration. If these boundary conditions are well chosen, hybrid welding becomes a very stable, efficient and flexible technology in which the control parameters of laser, MAG and machine can be varied freely over a wide range; this allows the process to be optimised with regard to welding depth, gap bridging, seam shape and metallurgical properties [2]. This is illustrated in figure 2 which shows welds over a wide range of focal position and laser-arc separations.

Physical model of the gap situation

An important question for industrial laser users is: What is the maximum gap that can be bridged and what factors determine this limit?

A simple physical model designed to answer this question is illustrated in figure 3. In it, the weight of the molten metal (density ρ and height t) above the root (width w_m), together with the dynamic pressure of a “downward” melt flow component with a velocity v_m, is balanced by the supporting capillary forces exerted by the surface tension σ of the root melt. The gap width w

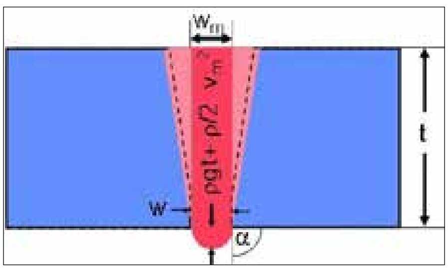


Figure 3. The pressure balance at the root

determines the minimum possible root width whilst the root width determines the minimum possible root radius $w_m/2$, which occurs at a contact angle α=90°. By setting gap and root width identical, the balance equation can be resolved for the maximum gap width w_{max}:

$$w_{max} = \frac{2\sigma}{\rho\,(gt + v_m^2/2)} \qquad (1)$$

To adjust the process, first of all an appropriate wire feed rate has to be set for properly filling the missing volume. It is also clear that in order to fulfil the above condition of minimizing the root width w_m to the gap width w, the laser power used should be the minimum required to achieve full penetration.

Equation (1) presents three possibilities to maximize the allowable gap width w_{max}, which can be implemented by corresponding measures:

- Increasing surface tension σ by root protection with inert gas (if two-sided access is accepted).
- Reducing melt velocity v_m by ensuring a stable process with low melt dynamics, mainly achieved by a proper basic parameter configuration (see above).
- Avoiding gravitational effects by using weld position PC (i.e. horizontal weld position as defined by ASME).

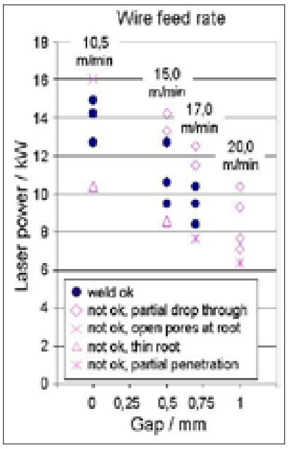
Equation (1) gives a reasonable quantitative estimation of gap bridging capabilities, which correspond very well with related experimental results [3].

Welding rules and weld properties

Comprehensive parametric investigations have allowed the development of control functions for setting welding speed, laser power and wire feed rate adapted to material thickness, groove preparation, gap width and welding position. As an example, figures 4 and 5 relate to a 15 mm plate thickness.

The data presented in figure 4 for a weld speed of 1.2 m/min shows a usable laser power range of more than 3 kW for a given gap width; conversely, at fixed laser power good welds can be produced over a significant range of gap widths. In this case a control function to vary the laser beam power according to gap width could even be unnecessary, but the wire feed rate does need to be controlled according to the gap width to avoid excessive weld reinforcement or underfill.

Figure 4. The process windows and gap bridging capability for laser-MAG hybrid welding of 15 mm structural steel in flat welding position (6°V, PA) with leading MAG at a constant welding speed of 1.2 m/min

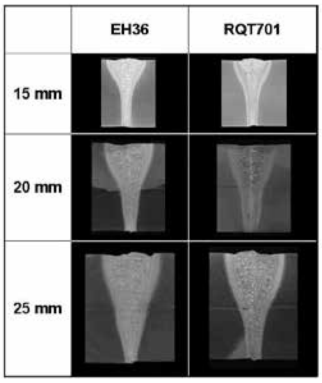


In figure 5 the smooth transformation from laser-MAG hybrid welding to pure MAG welding as the gap width increases confirms the robustness of the hybrid configuration used. The transition to gaps of up to 3 mm is achieved successfully by reducing the laser power, increasing the filler wire deposition and decreasing the welding speed in position PC. These three parameters are the control functions to be considered in practice for dealing with gap variations.

Welds without any hot cracks and with only very few small pores (if any), compliant with the highest assessment group B of EN ISO 13919-1, have been successfully produced in plates of thickness up to 25 mm. Cross sections of optimized hybrid welds are presented in figure 6.

In order to achieve crack-free welds, V- or Y-shaped groove preparation in the range between 4 and 8° full angle and an appropriate welding speed together with

Figure 6. Cross sections of optimized hybrid welds used for mechanical and technological tests



the right energy input per unit length are the crucial points to be considered. These measures ensure an ascending columnar dendrite structure upwardly curved and partly converging against the center line in the upper MAG-dominated cup-shaped part of the seam. In the lower laser-dominated “trunk” of the seam an equiaxial grain structure is dominant, which may change in the root to small columnar dendrites downwardly curved and either converging against the centre line or growing down to the root surface [2].

In the thickness range of 12 to 25 mm high-strength structural steel butt joints with excellent fatigue properties have been produced by hybrid welding at Fraunhofer ILT. This involved extensive uniaxial tension and 4-point-bend tests performed at IEHK of the Technical University RWTH Aachen, Germany and at CORUS in Rotherham, UK (Figure 7). The laser beam power as well as the welding speed must be adapted to the plate thickness and the gap width.

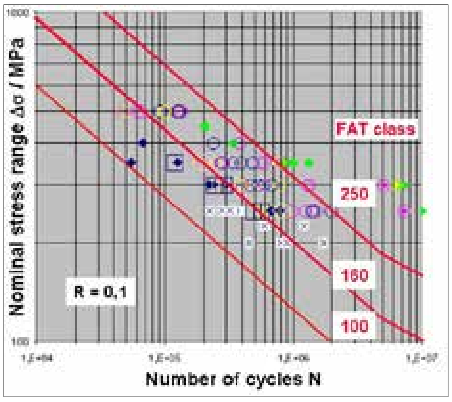


Figure 7. Fatigue results of laser-MAG hybrid welds up to 25 mm fulfil high FAT classes of Eurocode 3 [3]

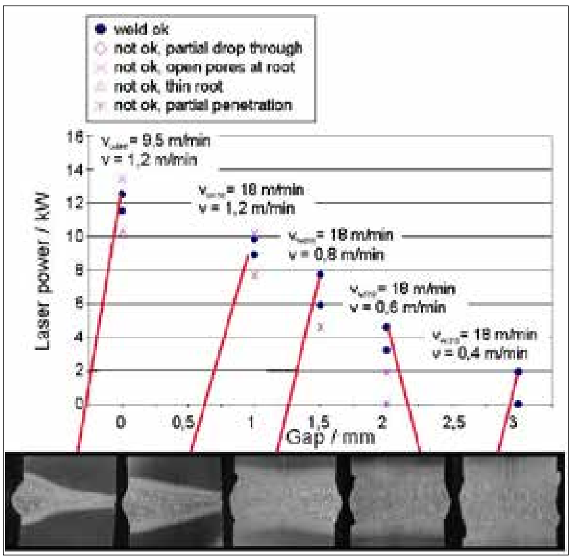


Figure 5. Expanded process windows and improved gap bridging capability for laser-MAG hybrid welding of 15 mm structural steel in horizontal position (6°V, PC) with leading MAG

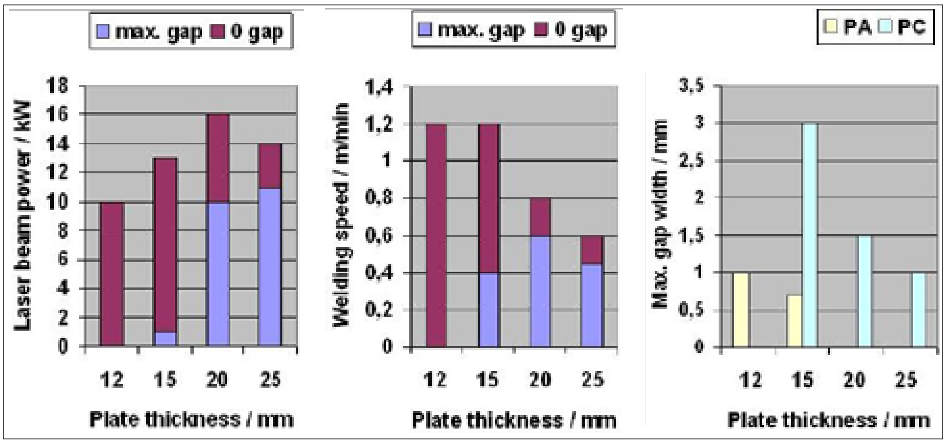


Figure 8. Optimized process parameters and welding capabilities versus plate thickness in single-pass laser-MAG hybrid welding of structural steel

Figure 8 shows the required beam power and the achieved process capabilities regarding plate thickness, welding speed and gap width.

A maximum thickness for laser hybrid welding high-strength structural steel of 30 mm was achieved in a single-pass configuration with satisfactory results, welding from both sides simultaneously with two MAG power sources. The weld is illustrated in figure 9.

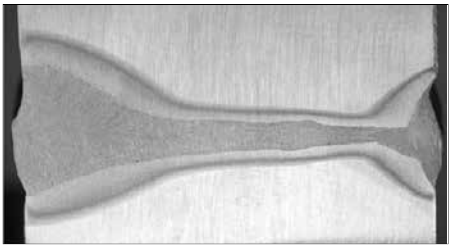


Figure 9. Single-pass laser-MAG hybrid welding of 30 mm high-strength steel (RQT701) with dual-MAG technology. Laser power 19.8 kW, 0.8 m/min

Enhanced Processing Capabilities by Combined Cutting and Welding

Sheet metal products – such as automotive components – are fabricated by sequential cutting and welding operations. Hitherto, these different processes were carried out on different machines i.e. the sheet components would be successively prepared by cutting, joined together and, for instance, completed by cut-outs or weld-ons.

The potential benefits of using a single machine that integrates cutting and welding include: a reduced process chain; substantially reduced cost of production; and greater flexibility in the manufacture of products. One way of achieving this is to employ the combi-head, which provides both laser cutting and laser welding without changing heads [4].

The combi-head allows for automatic switching between cutting and welding in a split second. Cost savings over conventional laser technologies include capital investment, floor space, operation and logistics; these amount to gains of over 50%. Above all, quality improves due to the higher accuracy of integrated laser processing, because former problems associated with process change-over are eliminated.

The dual function of the beam tool is enabled by the "autonomous nozzle", developed and patented by Fraunhofer ILT [4]. The industrial version of the combi-head from Laserfact is equipped with a fast response z-axis for automatic height control, with a newly designed multiple cross-jet for effective optics protection and a sealed optics module, with quick-change features for the cover slide and focusing device.

Case Study Non-Linear Tailored Blanks

A particular problem In the production of non-linear tailored blanks is the lack of precision in the prefabrication of the blanks, which causes gaps to form between the edges being joined. This can lead to either increased costs during the prefabrication phase, greater demands being made on the accuracy of seam tracking and gap measurement during the welding process, or even the use of filler material. In this context, integrated cutting and welding with the combi-head opens up new possibilities. Use of the combi-head allows precise cut edges to be made and reliable welding of the resulting perfectly matched workpieces, without the need to change tools or employ a seam tracking sensor.

A test series of blanks was prepared with the help of the industrial combi-head from Laserfact GmbH. A 4 kW fibre laser was connected to the combi-head by a process fibre with a diameter of 100 µm. The combi-head was mounted on a 6-axis industrial robot and the sheets were clamped on movable linear slides used for positioning. The steps in the process are illustrated in figures 10 and 11.

First, the edges of the blanks, two differently galvanized car body materials of thickness 1.0 and 1.2 mm, were laser cut at 8 m/min at a laser power of 1.5 kW, resulting in two perfectly matching edges. The edge of the first blank was then positioned against the edge of the second and the two pieces welded together at 8 m/min at a laser power of 2.2 kW, while remaining in their original clamping device. Finally, two elongated holes located exactly to one another were cut out of the newly-formed blank.

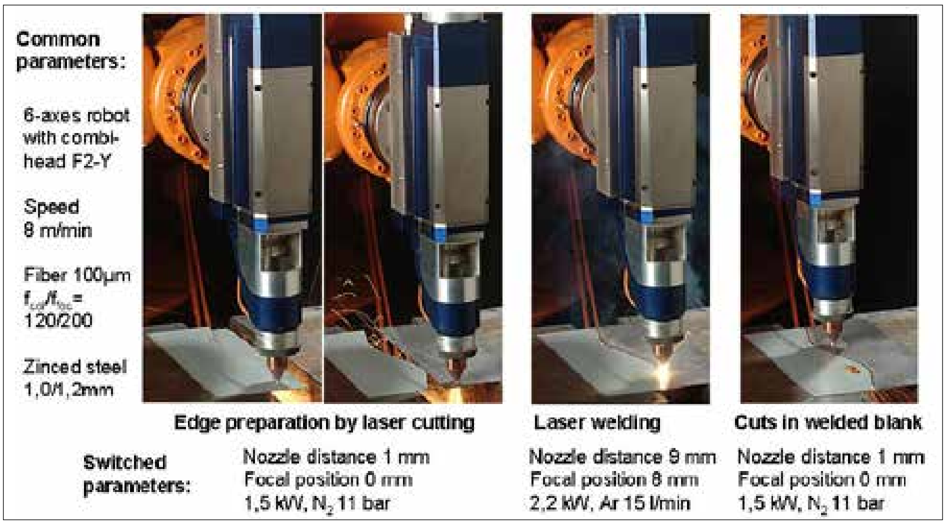


Figure 10. Non-linear TWB process chain using integrated laser cutting and welding with identical path concept

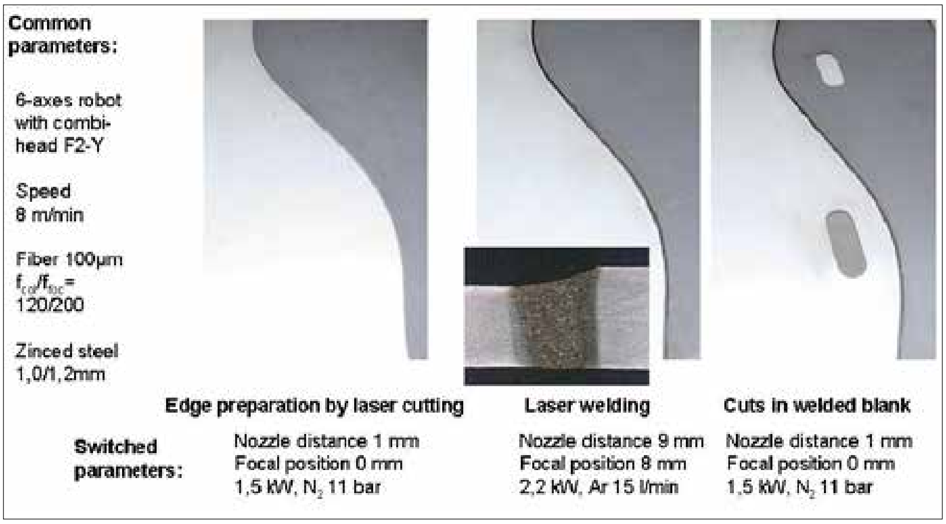


Figure 11. View of non-linear blanks after different process steps

The integrated process has been shown to achieve very high quality, even in non-linear cuts and welds. It is particularly worth noting that the welding line can be located without a seam tracking system, as the precise position of the weld is known to the machine coordinate system from the laser cut that precedes it. The weld line can therefore be identically (re)produced without any difficulties.

After welding, drill-holes, contoured cutouts or edge cuts can be performed on the metal sheets while they remain clamped. This option further enhances manufacturing flexibility and the number of different variants that can economically be produced. These subsequent cutouts can even be made across the weld itself, resulting in a high precision component. The integrated production of tailored blanks is a particularly cost-effective and flexible solution for the manufacture of small and mid-sized batches and can cope even with ultra high strength steels due to the integrated laser cutting process.

Conclusions

The achievements and results regarding laser-MAG hybrid welding of high-strength structural steel plates presented in this paper can be concluded as follows:

- Successful optimisation of hybrid welding process parameters
- Physical model and rules for improved gap bridging capabilities developed, allowing e.g. 1.5 mm gap @ 20 mm thickness (without root protection)
- Wide process windows for laser power versus gap width specified as well as control functions for wire feed rate and welding speed
- Hybrid welds produced with excellent fatigue properties, all compliant with more than FAT class 100 according to design S-N-curves of Eurocode 3
- Hybrid welds qualified without hot cracks and with properties according to level B of EN ISO 13191-1 up to 25 mm
- Laser-MAG hybrid welding extended up to 30 mm with a dual MAG process

The advantages of laser MAG hybrid welding could be confirmed for an increased thickness range. Important benefits are high welding speed, low distortion, the ability to bridge gaps, and the capability of single-pass full-penetration welding. Applications for the treated wall thicknesses can be found in pipeline construction, shipbuilding, load-bearing structures, off-shore engineering, special constructions and in heavy vehicle construction such as earth moving equipment.

Another option is the enhancement of productivity and flexibility in sheet metal fabrication by combined cutting and welding with a multi-functional combi-head. This is offering completely new perspectives regarding integrated process chains and versatile product design as demonstrated for non-linear TWB.

Acknowledgements

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See Observations p55

Comparison of low power Nd:YAG and fibre laser micro-welding

Mohammed Naeem and Steffan Lewis

Laser microwelding is used for joining high value miniature components in a range of industries including the electronic, telecoms, automotive and medical sectors. Typical applications include catheters or implants, orthodontic brackets, fibre optic couplings to laser diodes, hermetic seals, watch part components and other photonic fabrication devices [1-2]. Compared to conventional joining methods (i.e. resistance and TIG welding), laser micro-welding offers a number of advantages:

- **Low heat input -the weld energy is delivered only where it is needed and with exceptional control;**
- **Clean welds - in addition to the aesthetic benefits, clean welds result in products that are easier to sterilize or fit into other assemblies;**
- **Strong welds - laser provides high strength with minimum number of welds;**
- **Hermetic welds - unlike soldering or brazing, lasers can provide flawless hermetic welds essential for many micro- applications.**

For a number of years the lamp pumped pulsed Nd: YAG laser has been the laser of choice when fine welding of metals. At wavelengths of around 1 µm, focusing optics are smaller and simpler than for an equivalent CO_2 laser and spot sizes are smaller. The need for more efficient, compact and high beam quality lasers for very fine micro-welding has fuelled the rapid development of fibre lasers. These lasers operate in the same (near IR) spectral region as the Nd:YAG and offer a multitude of advantages over conventional lasers, including the promise of opening up new micro-welding applications (see insert).

Laser Performance

Low power fibre lasers are very compact and robust and offer a higher beam quality and wall plug efficiency than lamp pumped Nd: YAG lasers [3,4]. Current investigations [5,6] have shown that a single –mode fibre laser provides an efficient, reliable and compact solution for microcutting, microwelding and microdrilling.

An area where there is a significant difference between lamp-pumped Nd:YAG and fibre laser performance is pulsed operation. Lamp-pumped lasers are capable of producing long, multi-ms, pulses with peak powers many times the rated average power of the laser, provided the duty cycle is set sufficiently low. This ability stems from the flashlamp itself which is often more constrained by the maximum average thermal load than the peak power output.

Laser pulse shape

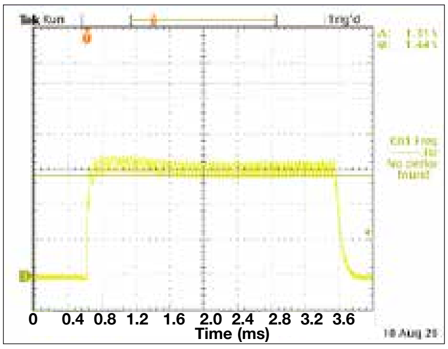


Figure 1: Standard temporal pulse shape of GSI pulsed Nd: YAG laser

Pulsed Nd: YAG lasers employ a power supply designed for delivering high peak powers during the laser pulse. Figure 1 shows the basic laser pulse; it is rectangular with an initial overshoot spike. As such, these lasers are very good for welding highly reflective materials, where the high initial peak power overcomes the thermal diffusivity and reflectivity of precious metals, copper and aluminium alloys. For metals such as high carbon steels, casting alloys, and a range of aluminium alloys are difficult to weld (i.e. the welds tend to crack or suffer pores or other defects) the ability to change laser pulse shape [10] may make it possible to produce defect free welds. Such pulse shaping is also often employed when microwelding highly reflective or dissimilar materials with very

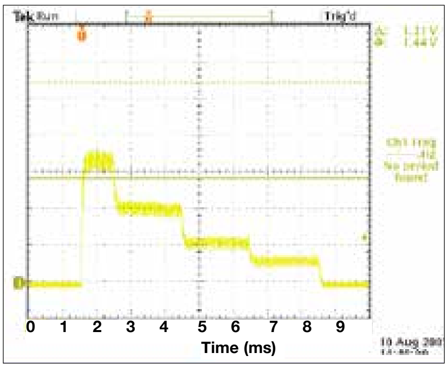


Figure 2: Ramp down (cool down) pulse

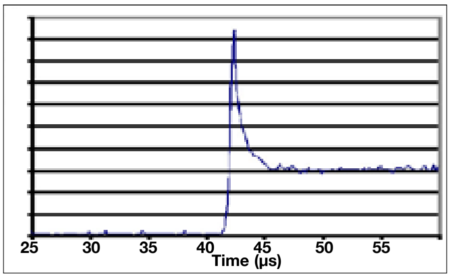
dissimilar melting points, where it can have a measurable effect on the quality and consistency. Figure 2 shows such a pulse, with a ramp-down (cooling) shape.

The ramp-down feature offers huge benefits in reducing cracks and porosity in welds. Without it, high carbon steels

Attractions of fibre lasers

The fibre lasers offer high beam quality and wall plug efficiency of order 25% [3,4]. The diode-pumped technology offers low maintenance cycles and high conversion efficiency. Theoretical pump-light conversions exceed 80% [7] but typical efficiencies for Ytterbium double-clad fibre lasers are 60-70% [8]. Average power levels up to 100 W are possible with air-cooling and most fibre lasers are powered by standard 110V/230V supplies.

The benefits of all-fibre single mode laser cavities have been widely discussed [9], with two of the principal advantages being the absence of optical alignment and exposed optical surfaces. The output fibre has a core with a diameter of less than 10 µm, ensuring a high beam quality output. This architecture is designed to be capable of producing output powers of up to 500 W with a 100,000 hour diode ensemble lifetime in a water-cooled heat sink configuration and up to 120 W using forced air-cooling, with the same level of diode reliability.



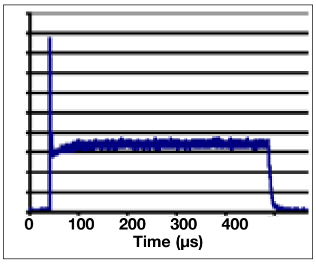


Figure 3: Fibre laser- Modulation Characteristics

Upper curve is expanded to show the leading 'spike'

(>0.25% C) can create a hard phase called martensite in the heat-affected zone of the weld due to the otherwise fast cooling rates. Crack sensitive alloys such as 2000 series, 6000 series aluminium alloys, and some high strength steels can also benefit from slow cooling [10]. In some applications, it is possible to have over 10 sectors in this type of pulse shape but usually 3-5 is sufficient.

By contrast, while the semiconductor laser diodes used to pump a fibre laser can be on-off modulated over a wide frequency range (from DC to tens of kHz in most industrial applications), they cannot typically be over-driven for long periods (multi-ms), in the same way as a flash-lamp can, without seriously reducing the lifetime of the device. Typical diode laser modulation characteristics are shown in figure 3.

Nd: YAG vs. fibre

The differences in beam quality and pulsed performance of these the two types of laser mean that they operate in different regimes. The lamp-pumped YAG laser is characterised by long high-energy pulses but poorer beam quality, and the fibre laser with high repetition rate on-off type modulation, single-mode beam quality but low pulse energy. From an applications perspective, both of these regimes have their advantages as discussed below.

Experimental Work

Pulsed Nd: YAG laser

Microwelding tests were carried out with GSI's latest Nd:YAG low power pulsed laser (JK125P). This laser offers high beam quality, small spot sizes and high pulse to pulse stability. These properties are summarised in Table 1

JK125 beam parameters

Maximum average power[1]	125 W
Maximum peak power[1]	2.3 kW
Maximum pulse energy[1]	17 J
Pulse width range	0.1-20 ms
Maximum frequency	1000 Hz
Pulse to pulse stability	±1% from cold
Beam quality[2]	7 mm.mrad
Fibre diameter	150 um
Pulse shaping	20 sectors

1 rated at the end of lamp life

2 half angle radius

Table 1: Performance data of a pulsed Nd: YAG laser

Single mode (SM) fibre laser

The GSI SM 200 W single mode Ytterbium fibre laser operates at 1080 nm wavelength and emits a gaussian beam with an M^2 ~ 1.10. In CW mode the laser is capable of producing high brightness and high power densities as high as 10^8 W/cm^2, which is sufficient for cutting and welding thin metals. They can also be modulated and provide pulsing capabilities with pulse widths ranging from microseconds to milliseconds. Pulsed operation is obtained by gating the laser with an external pulse generator. Figure 4 shows a typical individual pulse of the gated fibre laser.

Micro-welding tests

The fibre laser was set up with a scanning head and the scanner was fitted with a 160 mm focal length lens. The calculated spot was approx 30 µm. The focus position during the experiments was kept on the top surface of the sample. No shielding gas was used for 304SS welding whereas argon (10l/min) was used during titanium welding. Melt runs were made by scanning the laser beam across a stationary workpiece.

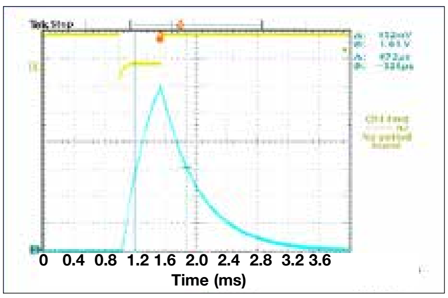


Figure 4: Temporal behaviour of a gated fibre laser

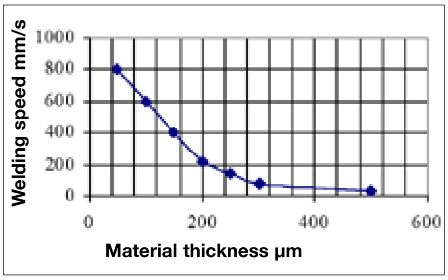


Figure 5: Material thickness vs. welding speed for the 100W fibre laser on 304 SS

For pulsed Nd: YAG laser welding the beam from the laser was transmitted in a 15 m x 150 µm fibre optic, which terminated in a 200 mm output housing fitted with focusing optics. The output housing was fitted with a 200 mm focal length recollimating lens and an 80 mm focusing which produced a calculated spot size of 60 µm at the workpiece.

Results and Discussion

Fibre laser

In order to characterise the performance of the 100-200 W fibre laser, welding trials were carried out in thin sheets of stainless steel, titanium alloy, copper and aluminium alloy. Typical welding speeds for 304SS with a 100 W are summarised in figure 5. As a result of the high beam quality of the fibre laser the welding speeds were very high when welding thin foils. However, as the thickness increases average power becomes more important than focused spot size, the extra power being needed to keep the molten pool going. Figure 6 shows the cross sections of weld bead on 100 µm thick foil made at 600 mm/s with a power of 75 W. Fine weld bead of keyhole mode was obtained without humping up to at least 600 mm/s, corresponding to a heat input of 1.25 J/cm. The welding speed for 500 µm thick material was 30 mm/s, corresponding to a heat input of 25 J/cm. Figure 7 shows typical heat input values for different material thicknesses.

The CW weld performance for titanium alloy (Ti-6Al-4V) alloy was very similar to the weld performance of 304SS; however the heat- affected zone was slightly wider. This may be due the lower conductivity of titanium (by a factor of two)

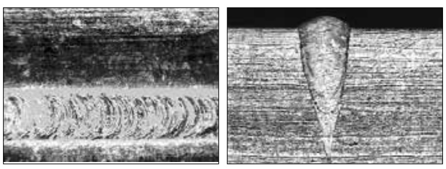


Figure 6: 100 µm thick 304SS foil welded at 600 mm/sec

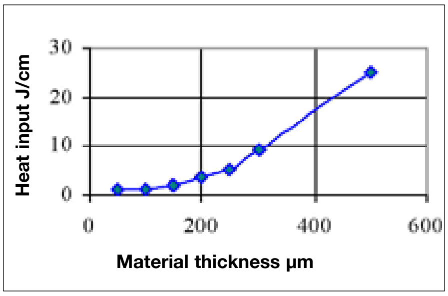


Figure 7: Heat input as a function of material thickness for fibre laser welding of 304 SS steel

[11]. With CW output, it was not possible to weld aluminium, copper and brass. Brief welding experiments were also performed with pulsed parameters i.e. frequency, pulse width and peak power to see if it was possible to weld aluminium, copper and brass. The results showed that the peak power was not sufficient to effectively couple into these materials. However with a 200 W fibre output it was possible weld very thin foils of aluminium and copper. Typical welding speeds for these materials and also for 304SS are highlighted in Figure 8. Work carried out BIAS Bremer Institute with a SM 200 W laser [12] showed that it is also possible to weld thin foils of dissimilar materials e.g. a combination of stainless steel and copper for electronic connectors.

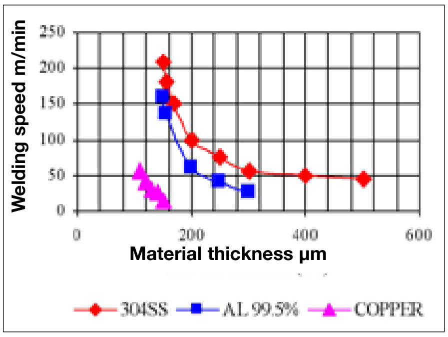


Figure 8: Welding performance of a 200W SM laser

Pulsed Nd: YAG laser

The result of this work showed that with a lamp pumped Nd: YAG laser it is possible to weld a range of materials including aluminium and copper and combination of dissimilar materials as well, using

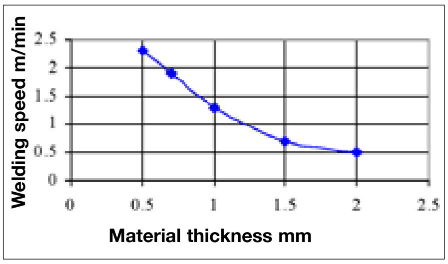


Figure 9: Welding performance of 125 W pulsed laser (304SS)

pulse shaping to control the temperature in the region where the two molten phases are mixed [11]. Weld depth similarly must similarly be controlled: too deep can lead to defective joints, but insufficient weld depths must be avoided by adjusting the high starting power and correctly decreasing the power thereafter. Figure 9 summaries welding speeds achieved with JK125 laser for 304SS.

The pulsed Nd:YAG laser is also successful at micro joining difficult or dissimilar materials.

Summary

The increasing complexity of microelectronics/ engineering devices and the requirement for higher yields and automated production systems place stringent demands on the assembly techniques and performance requirements of materials and joining techniques. This has led to increasing interest in the use of low power lasers for microwelding of small assemblies. Of particular interest to micro-component industries is the ability of such lasers to apply controlled amounts of energy in precise areas, utilizing extremely low heat input, resulting in very low distortion, and coupled with the ability to operate at high production rates in a flexible manner.

This study has found that the 100 W SM fibre laser with its very high beam quality and small spot is well suited for microwelding thin foils of 304SS and titanium alloys up to 1 mm. It was not possible to weld reflective materials i.e. aluminium and copper base alloys at this power level. However, with the 200 W SM fibre laser it was possible to weld thin foils of aluminium and copper as well as 304SS and titanium alloys.

This study also found that a low average power (100 W), Nd: YAG laser with high power and enhanced control and complex pulse shaping facilities offers greater flexibility for microwelding a wider range of materials. With correct shaping of the temporal energy variation in pulse (pulse shaping) it was possible to produced good quality welds in a range of materials including ones with high reflectivity materials (such as aluminium, copper alloys) and dissimilar materials.

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Welding high stiffness slot – tab aluminium closed-box structures using a high beam quality laser

Christian Walz, Frank Priebe, Renald Schedewy, Dirk Dittrich

Laser beam welding is a key manufacturing process for a closed-box design used in integrated aircraft structures. A closed box design build of laser cut sheet metal components offers the possibility to create an integrated structure with very few manufacturing steps. This sheet metal design offers a high stiffness low weight solution.

For the study reported the lightweight structure shown in figure 1 was fabricated from sheets of 6xxx series aluminium 1.2 mm thick. The sheets were laser cut with small slots of 1.2 mm width. The assembly was self fixturing using press fit slot-tab joints. The joints were then laser welded from the outside.

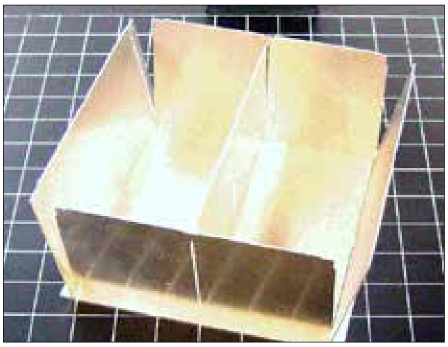

Figure 1. Self – fixturing closed box structure

The main advantages of this structure are its easy manufacturing chain and its flexibility for quick design changes. Welding from the outside reduces the positioning effort for integrated closed box designs. Other designs, for example using T-joint welded through a closed cover sheet require significantly larger positioning effort. Moreover, the slot-tab design enables the use of optical sensors for seam tracking.

Figure 2 shows the design of the closed box structure of the large demonstrator. The vertical ribs are indicated as rectangular sheets for better illustration. The top of the rib sheets matches with the top surface of the cover sheet. Additional front and back sheets are

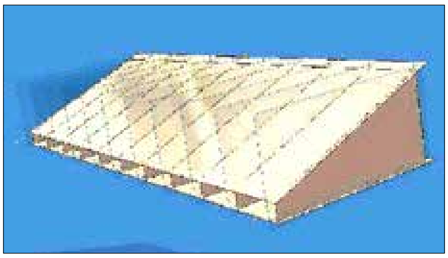

Figure 2. Design of larger demonstrator

welded in to close the box. This larger, more complex shape was the test structure for the second step. The sheets for this demonstrator were 1 mm thick for the top, bottom and rib sheets, and 1.5 mm for the front and back sheets.

State of the art

Laser welding of closed structures is best known from applications in the steel area [1]. Shipbuilding structures have been successfully welded with a "hidden" joint geometry. Due to larger tolerances in the shipbuilding industry, the steel joints incorporated a small threaded pin to get a tight fit between the rib and the cover sheet.

Set-up and parameters

The investigations were carried out in two steps. The first step was welding a small scale box, to fix the preliminary set of welding parameters with two laser: a 3.5 kW disc laser from Rofin Sinar and a 4 kW fibre laser from IPG. The factors investigated in this part of the study included laser power, welding speed and strategy, focal position, mono/twin-spot configuration. Both lasers were compared regarding the resulting weld geometry, the distortion and manufacturing concerns.

The second step, based on the larger demonstrator, focused on the feasibility of scaling up the process and to determine the resulting distortion. Different welding strategies have been applied in this step as well in order to minimize the distortion. The welds were evaluated for penetration depth, weld geometry, seam reinforcement, distortion and welding speed. No filler wire was used.

The handling system for the disc laser was a five axis linear gantry system, a robot was used for the fibre laser.

Twin-spot trials were carried out with the disc laser, using an optical wedge to split the beam and allowed welding of two butt – joints simultaneously.

The fibre laser was combined with 3D-scanning optics developed by the Fraunhofer IWS, as shown in figure 3 [2]. Combining the scanning optics with the handling robot in this way produced a coupled axis system with a large working envelope. The macro movement along the weld line was carried out by the robot while the scanning optics manipulating the beam perpendicular to the line.

The high beam quality of the fibre laser (2 mm*mrad) allowed the use of a long focal length, which widened the working envelope of the scanning optics. A 125 µm focus diameter was realized with a 300 mm focal length. Variables were the amplitude and the frequency of the scanning beam.

In the second step larger demonstrators of 450 mm x 1300 mm were welded.

Figure 3. 3D- laser scanning optics

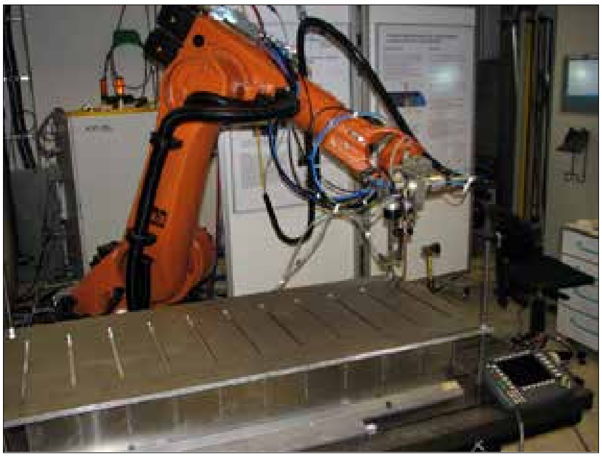

Figure 4. Welding jig for large demonstrator

All sheets were pre-assembled before fixturing in a jig to ensure proper positioning during welding and improved the heat flow from the components. Figure 4 shows the welding jig for the larger demonstrator with the cover plate slotted for the laser beam.

Results and discussion

The first welding trial with the disc laser with two subsequent welds on each side of the rib did not lead to acceptable welds. The distortion due to the first weld produced a gap on the other side of the rib, resulting in the second weld showing strong undercuts and holes.

The twin-spot optics led to welds with sufficient weld depth and width, but these welds had undercuts as well. These undercuts resulted from gaps present before the welding due to tolerances in the laser cut slot. Figure 5 shows a good weld carried out with the disc laser with a twin-spot configuration.

The welding speeds were acceptable for the targeted application and although the overall weld length per box in the first step was more than one meter, the distortion was low due to an optimization of the welding strategy. Production with twin-spot welding would be complex because of the difficult alignment of the two spots along the two small weld lines.

Figure 5. Cross section of weld with disc laser

Very few crack occurred in the welds including the start and stop region; this despite the fact that more cracking was expected due to the fact that we were welding the 6xxx series alloy without filler wire.

The welding of the larger box was undertaken with the scanning optics arrangement (as shown in figure 3). The laser was oscillated perpendicular to the welding direction. Tests were performed using sinusoidal and rectangular shaped oscillations; the former producing the best results. The welds with this configuration had sufficient weld depth and width ;and the "simultaneous" welding of both sides of the rib prevented a gap opening up.

The weld geometry revealing an undercut that is smaller than for the results of step one. Very few small cracks occurred in the end section of the welds.

One challenge of the slot-tab design is the tight tolerances it places on the laser cut slots, in particular because any gaps arising from inacuracies in the laser cutting process lead to a gap which, because filler wire is not used, might not be bridged. Therefore precise laser cutting is essential. Welding of joints with no gap resulted in welds with no undercut, as shown in figure 6a.

Welding with the high beam quality lasers was possible at speeds of up to 12 m/min, leading to a low heat input at sufficient weld depth. One major aspect of the welding tests was the distortion of the components. Figure 6b shows the welds still showed unacceptable distortion.

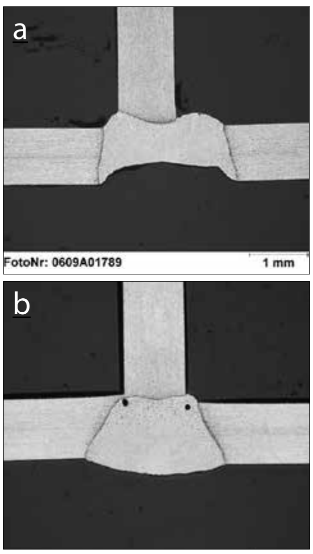

Figure 6. Cross section of a scanner welded part:
(a) with undercut due to gap formation;
(b) without gap

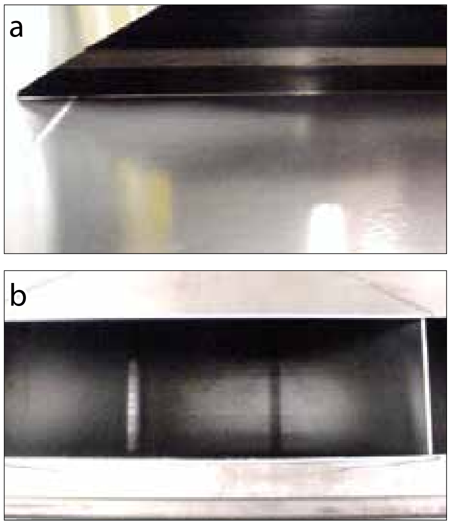

Figure 7. (a) Distortion of welded part after optimization; (b) Front view

In an attempt to reduce the level of distortion the effect of various factors was evaluated:

<u>Heat input</u>
The heat input was reduced by a reduction of the line energy.

<u>Welding strategy</u>
Changing the weld length and arrangement affected the welding strategy.

<u>Welding sequence</u>
The welding sequence was modified by the order in which the single welds were welded.

<u>Fixturing</u>
Optimization of the fixturing was realized in order to increase the heat flow from the part into the fixture.

Figure 7 shows the welded structure after optimization. The distortion is low even without the front and back sheet in place. The front view of the welded part after optimization shows that the overall structure is flat on the top and bottom side.

Tack welding of these two sheets before welding the structure led to an additional reduction of the distortion, see figure 8 overleaf. The reflections on the surfaces show the absence of bulging on the cover sheets.

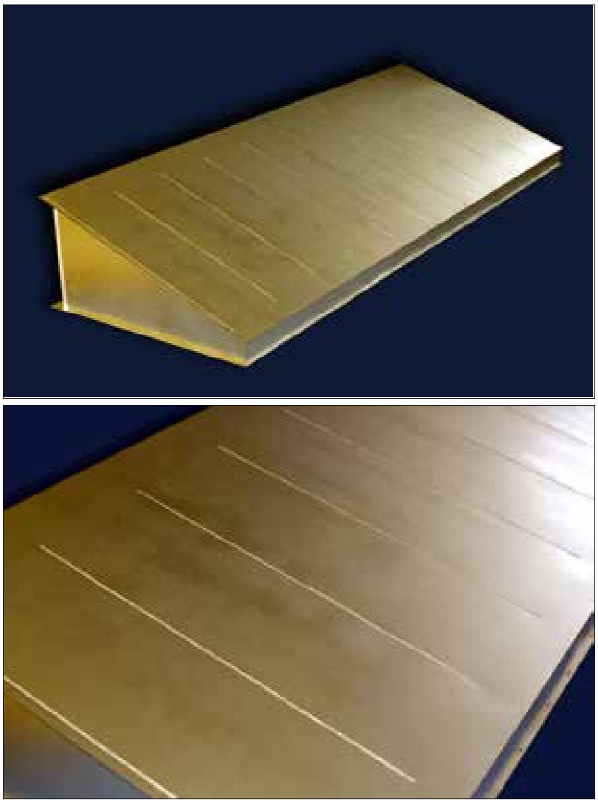

Figure 8. Photographs of the scanner welded closed box

Future optimization

It was clear from the evaluation of weld geometries and distortion that there is a need for optimising the following factors:

- The design, to reduce undercuts;
- The welding strategy, to reduce distortion;
- Further reduce the line energy to reduce distortion;
- Improve the laser cutting process to reduce the gap and thereby the undercuts.

Optical sensors would allow seam tracking prior to welding, which would optimise the process times especially after design changes.

Potential applications

This advanced self-fixturing design has potential for many sheet metal applications.

The simple design principle allows flexible chances of the design even during production. Very little changes in fixturing are required to realize a change in design.

Today's high high power high brightness lasers offer the possibility extend the welding principles previously applied to steel to aluminium and to other materials.

Potential applications include structural components for the aircraft industry, shipbuilding components or other integrated structures and frames.

Conclusion

The subject of this project was the laser welding of a closed box structure. A new self fixturing design allowed welding of a 3-dimensional box with very little fixturing effort.

Different laser sources and welding optics have been tested. Weld geometry and distortion were the main focus of evaluation.

Welding with a high beam quality laser and a scanning optics led to the most promising results. Weld geometry and the process performance were within the target range and the distortion of larger components needs further optimization. Similar trials with a CO_2 laser were not successful.

The welding was carried out at the Fraunhofer IWS in Dresden.

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Case Study: Remote welding in the automotive sector

Thomas Schwoerer

One of the main drivers for industrial laser applications has been the automotive industry. Laser cutting and particularly laser welding are increasingly used in the manufacture of the car body and frame, engine and power train, seat frames and many other parts.

Most successful has been the use of solid state lasers with optical fibre delivery and beam-sharing capability, in combination with robots due to their flexibility in the installation of solid-state lasers featuring and flexible laser light cables for transporting the beam to the work pieces. The development of such laser processes started with conventional laser applications where only the robot motion defined the processing geometry. In the next step, the robot motion was combined with the motion of highly-dynamic optical scanner system. This combination of technologies allows to utilise synergies of the flexibility of 3D robot processing and highest productivity from the dynamics of laser scanner optics. Advanced robotic laser scanner welding has become the benchmark for efficient and economic high volume production. Productivity of these technologies is several times higher when compared to conventional welding technologies.

Laser source design

Over the last few years solid-state laser technology has evolved from lamp-pumped rod systems to the so-called high brightness diode-pumped disk and fibre laser systems. The use of diode emitters greatly increases the optical efficiency of the pumping source (e.g. to ~ 65% for disk lasers) and the improved conduction of the disk and fibre geometry over that of the rod greatly reduces thermal lensing and its effect on achievable beam quality. For example, new disk lasers are designed in such a way that the temperature inside the crystal disk laser remains constant across its surface.

The current generation of Trumpf disk lasers are able to generate 2 kW per

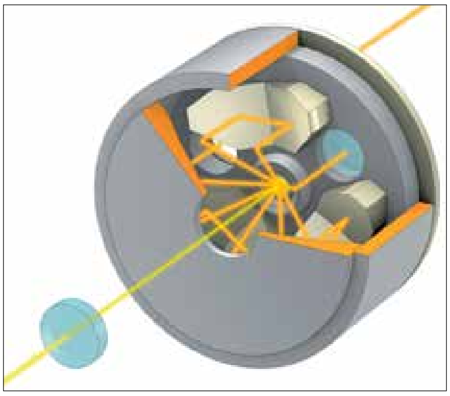

Figure 1. Principle of a disk laser cavity. The pumping beam from diode pumping stacks is reflected multi-fold via mirrors inside the cavity to pass up to 20 times through the disk

disk crystal, heading for 4 kW towards the end of 2008. Figure 1 illustrates the design of a disk laser cavity. By combining several individual disk cavities the total available laser power of a disk laser is virtually unlimited; for example, based on an existing 4-cavity design, a laser power of 16 kW will soon be available.

Key features claimed for the Trumpf disk laser in addition to high power and brightness include: insensitivity to back reflections from the workpiece; availability (uptime) greater than 99%; and modular construction, allowing all components to be replaced and maintained in the field.

Remote welding optics

The high beam quality of disk lasers allows for the design of new optical processing heads with longer focus distances, without sacrificing the processing speed or focus spot size. For example, the beam quality of a 4 kW Disk Laser (8 mm*mrad) is three times better than that of a 4 kW lamp-pumped laser. This allows a three times longer focusing length while maintaining a focus spot diameter of about 0.6 mm, the typical spot size for deep penetration welding. This makes possible the use of remote welding optics with a focal length of 0.5 m or more. The greater working distances significantly reduce optics contamination, thereby reducing running cost.

A remote welding head incorporates scanning optics (i.e. movable mirrors driven by galvanometer motors) to position the beam focus within the processing area. Programming such scanner optics enables the realisation of any weld shape within this area. The high speed of the mirror movement means that there is virtually no time lost in re-positioning the beam between welds. Figure 2 illustrates the principle for three-dimensional scanner optics.

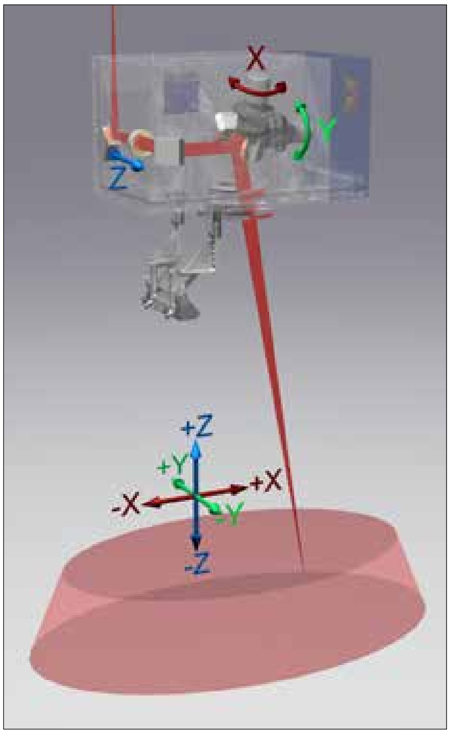

Figure 2. Principle of programmable focusing optics. The two galvanometer drives position the beam in X and Y while the movement of a lens positions the beam in the Z direction

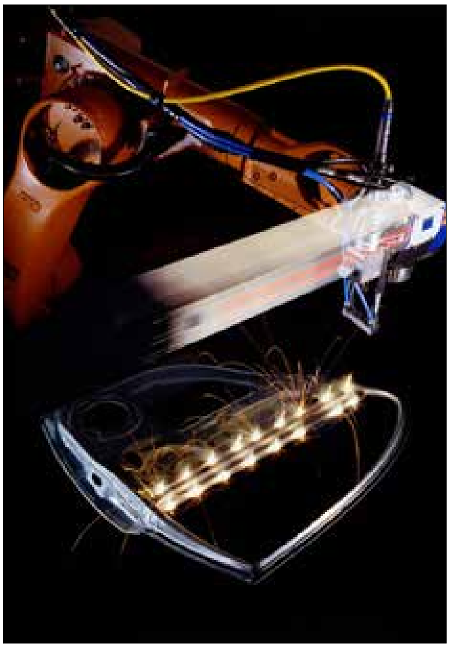

Figure 3. Welding "on-the-fly". The robot does not stop during welding. Motion controller of robot and scanning optics are fully synchronised to produce the programmed welding patterns, even if the robot path and/or velocity changes

Characteristics of the Programmable Focusing Optics unit (PFO 3D) shown in figure 2 include high speed positioning in all axes; repositioning from one end to the other end of the full range in X, Y and Z in less than 30 ms; and coordinated motion capability for processing of any weld patterns, e.g. lines, circle, brackets.

Trumpf's scanner controller systems can be coupled with a robot motion controller, allowing full synchronisation of the scanner with the robot motion. This allows extremely fast material processing, the scanner optics being moved in space by a robot to enlarge the processing space and allow 3D access to the part being welded. Such "on-the-fly" capability provides the most productive welding technology available. As the photos in the title banner and figure 3 illustrate, the high transition speed of the laser beam from weld to weld makes viewing the process by eye a case of 'follow the fireworks'.

Remote welding applications

The welding performance of a robotic laser scanner system strongly depends on the laser power used and the design of the scanner optics: generally, the higher the laser power the higher the welding speed.

Most applications in the automotive area are concerned with welding sheet metal between 0.6 mm and 1.5 mm thickness. In case of welding two 1 mm thick sheets together and a disk laser power of 4 kW the effective welding speed would be ~100 mm/sec. The real boost in productivity results from time savings to re-position the focus point from one weld to the next.

Item	Units	Spot resistance welding	Laser scanner welding
No. of welds	welds	35	35
Required equipment	robots	4	1
	welding tools	5 guns	1 scanner
	part identification	1 mechanical punch	No additional tools required (laser marked)
Cycle time	seconds	~35	~13
Throughput	%	100	270

Table 1 Comparison of technologies

Many automotive manufacturers around the globe—among them large OEMs like Daimler, Audi, Volkswagen-and various OEM suppliers, already apply this technology for high volume production of various components and car bodies. Examples are doors (see figure 4), side panels, rear shelves, seats frames, and other sub-assemblies of high volume.

<u>How productive is laser scanner welding in practice?</u>

To illustrate the performance gain of laser scanner welding, Table 1 compares it to classical spot resistance welding for welding of rear shelves in the Volkswagon range. The key advantage is seen to be a reduction of cycle time by a factor of approximately three. This increase of productivity was achieved with a TruDisk 4002 with 4kW laser power. Such significant improvements have to be aligned and coordinated with material flow inside the plant. Therefore, more than 4kW of laser power may often not be of further advantage.

Figure 4. Welding a car door

Experience from various real applications has shown gains in productivity between 2 and 6 over conventional spot resistance welding. However, to determine the exact increase of any given part various factors come into play: size of part; number of welds per part / total weld length; weld location / distribution across the part; laser power available; focus spot size and work space of scanner optics; synchronised motion "on-the-fly" or "stationary" welding operation; and robot reach.

Shape, length and distribution of the individual welds may be part-specific. Experience has shown that many non-circular laser welds show higher strength than round, circular welds used in spot resistance welding. This is due to better distribution of forces of laser welds, not concentrating on a single spot, as illustrated in figure 5.

Another issue for today's welding applications is high-strength steel. Yield strengths continue to increase and have

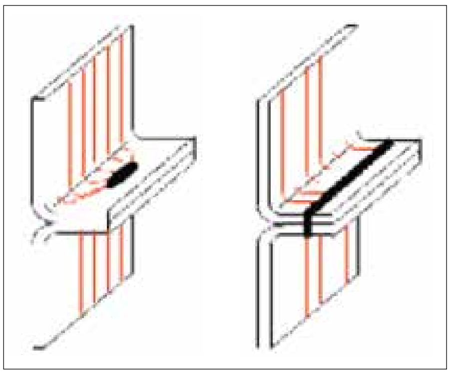

Figure 5. Flow of forces within a weld, comparing (left) spot resistance welding with (fight) laser stitch welding. Laser stitches are programmable and can be of any shape

already exceeded 1,000 MPa. In principle, the higher the strength of steel, the higher its sensitivity to heat input. Laser beam welding remains a preferred methodology for welding high-strength steel thanks to the lower heat input of laser applications compared to that of spot resistance welding and MIG-welding. Yet another side effect of reduced heat input is the reduced distortion of the part.

Zinc and Laser Dimpling:
An important consideration for welding of steel materials is zinc. State-of-the-art steels for automotive body production are typically zinc-coated on both sides. Zinc vaporises at about 900°C when the underlying steel is not even melted. Hence, when welding two pieces of sheet metal high vapour pressures can be generated between them. If there is no gap between the sheets to relieve the pressure then this can lead to blowouts of molten material, mostly through the top sheet, leaving a weakened and leaky weld. Thus, a gap is required.

Although, in principle, there are many possibilities for producing this gap, laser technology may offer the most flexible and versatile solution: laser dimpling. This additional process step would be conducted before the sheets are brought together using the same laser and scanner equipment as for the welding later, modifying the typical process steps as follows (figure 6):

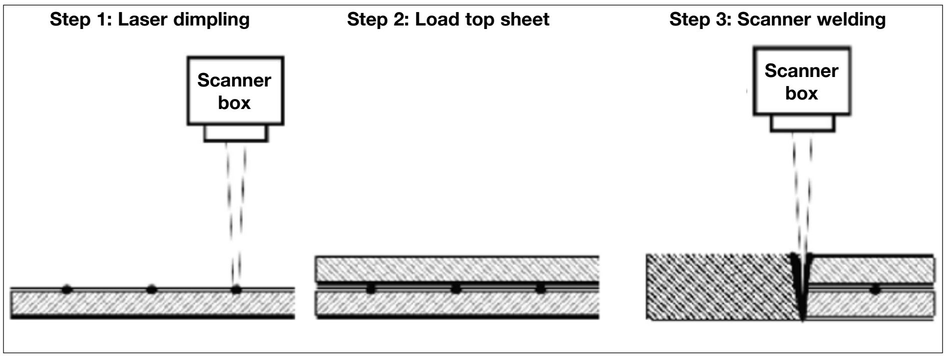

Figure 6. Process sequence for laser dimpling. The dimples generated by laser spot welding maintain the correct distance for ease of clamping. The laser parameter can be adjusted to produce a reproducible dimple height, typically between 0.1 mm and 0.2 mm.

1. Laser dimpling of one sheet in areas of later welding
2. Loading of top sheet. Dimples maintain constant gap for zinc degasing
3. Laser scanner welding

Dimples can be produced very cost-efficiently using the same equipment, and with high repetition rates. A dimple can be produced in about 10 milliseconds.

Summary
Laser technology today is a widely accepted and capitalises on high system flexibility and throughput for high-volume production. As shown in this article, advancements of disk laser sources and scanner optics enable stable and highly-efficient remote laser welding processes. The significant advantages in processing time mean that less equipment is needed in comparison to other welding technologies and hence higher production throughputs can be achieved with less equipment and floor space.

This technology has already been successfully introduced in the European automotive industry in high volume car manufacturing and is expected to contribute to cost savings and higher flexibility for body shop applications and tier suppliers, today and in the future.

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Laser and Photonics Marketplace
19 June 2008 Aston Science Park

At this year's annual Meet the Editors event, Stephen Anderson editor-in-chief of Laser Focus World and David Belforte editor-in-chief of Industrial Laser Solutions were joined by Arnold Mayer of Optech Consulting who presented an overview of the economic impact of photonics in Europe as a whole. These these presentations of global market-intelligence are available on the the AILU web site in the resources library in the member's area ('strategy' section).

Laser marketplace speakers (l to r) Stephen Anderson (Laser Focus World); Stuart Wood (Coherent); David Belforte (Industrial Laser Solutions); Arnold Mayer (Optech Consulting); Alastair Wilson (Photonics KTN); Glenn Barrowman (Photonics Cluster).

Both editors' presentations were upbeat, noting continuing growth in their sectors. It was noted that industrial laser sales have now seen 37 years of continuous growth. Expectations are for a 7% growth worldwide this year. Relatively slow growth in Western Europe has been more than balanced by massive growth of sales in Eastern Europe; similarly, while sales in Japan are slowing, growth in China last year was 40%. As expected, fibre laser based systems showed the greatest growth rate among laser machines; 30% last year.

The meeting also included a presentation by Stuart Wood of Coherent who made a persuasive argument that for marking applications in general the Diode Pumped Solid State Laser was superior to the fibre laser in terms of cost of manufacture, flexibility in design, choice of wavelength and peak power.

Freeform fabrication of dental inlays by laser micro-sintering

Peter Regenfuss, André Streek, Lars Hartwig, Matthias Horn, Sascha Klötzer, Robby Ebert and Horst Exner

At the present time two groups of materials are interesting for ceramic inlays: pure ceramics and material compounds consisting of an inorganic filler and an organic binder. Pure ceramic specimens are usually produced in dental laboratories. Special CNC equipment has been available for several years, which allows the cutting and grinding of industrial preforms according to a scan of the cavity and its dental environment or according to a replica imprint of it. The principal idea of such systems is that the process can be carried out by the dentists themselves. However, not only do many dentists prefer to spend their time practising their expertise (rather than operating a CNC machine) but the grinding or cutting tips of these machines are subject to constant and gradual wear.

For these reasons the idea to produce ceramic inlays with a freeform technology was brought to the attention of Laserinstitut Mittelsachsen e.V. by an interdisciplinary team comprising a dentist and two economists. Shortly before this, the laser research group had produced metal micro-parts by a new modification of selective laser sintering. The resolution achieved, 30 µm, seemed just appropriate for the requirements of dental fillings. Moreover, the fact that each dental defect has its unique shape makes the generation of dental inlays a prime case for the economic application of freeform technology. The big challenge was to transfer a technology that had previously only been successfully applied to generating micro parts from metal powder.

Laser micro-sintering

The principle of selective laser sintering is the repeated coating and selective densification (sintering) of powders or pasty materials with the aim of generating a three-dimensional body layer by layer. Of each powder layer only the respective area that is part of the intended object is sintered by selective irradiation with a laser beam as illustrated in Fig. 1. Subsequently the probe piston is lowered by a certain amount and the following powder layer is coated on top of the previous powder bed as well as the already generated stump of the object. After this the next selective sintering step is performed, and so on. Since its invention by C. Deckard & colleagues [1] Selective Laser Sintering has been continuously improved to meet the requirements for the production of functional components [2]. In early 2003 Laserinstitut Mittelsachsen e.V. (Germany) demonstrated that an innovative modification, generally known as laser micro-sintering, made it possible to shift the resolution of selective laser sintering considerably below the confinements of conventional laser sinter systems.

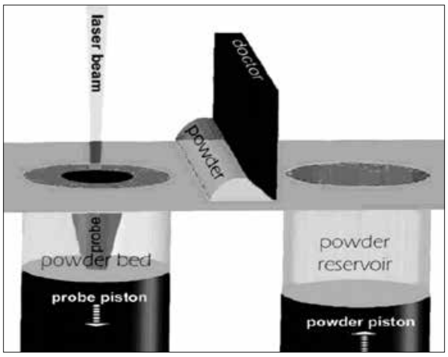

Figure 1. Schematic of SLS

High resolution sinter bodies from metal powders

Micro and sub-micro grained powders are necessary for resolution in the range of 10 µm-30 µm. These powders usually show a voluminous consistency rather than settling into a dense layer. When laser sintering of those layers was attempted using a continuous-wave (cw) laser beam at moderate intensity the material would melt and contract into solitary spheres with little or no attachment to the substrate below. However, these difficulties were solved by using a q-switched beam. By delivering a pulse of high peak power and relatively short pulse duration a rapidly expanding plasma is produced that exerts a condensing effect onto the molten material. Also, the rapid heating and subsequent cooling cycle minimises collateral melting which in turn allows pulse-wise sintering and guarantees a high resolution over the specimen's cross section [3]. In this way overall resolutions of less than 30 µm and aspect ratios of 12 and above at a minimal roughness Ra of 1.5µm can be realized in metal parts as shown in figure 2.

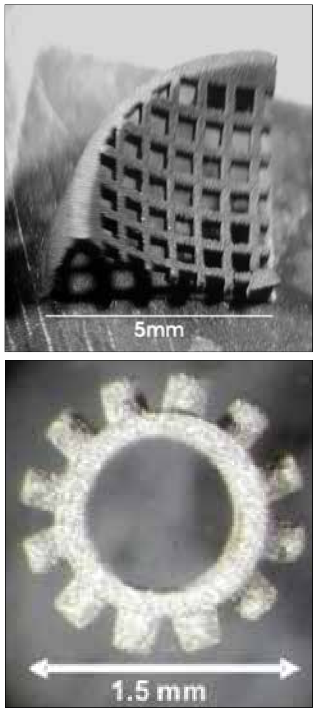

Figure 2. high resolution sinter bodies made from metal powders by SLS

(top) Sieve insert from tungsten power

(bottom) Cogged wheel from silver powder

From metals to ceramics – adaptation of the technique

Experiments on selective laser sintering of ceramics began about two decades ago [4, 5]. They dealt mainly with the generation of green forms via selective solidification of an organic binder followed by pyrolysis of the binder and final furnace steps with considerable shrinkage. Those procedures have now reached a very high level of refinement and are nowadays performed by commercial machines [6, 7]. Considerably fewer reports are available on direct selective laser sintering of this material class [8, 9].

A sinter process with a high shrinkage requires precise anticipation of and compensation for the deformations inherent with the technique in order to maintain sufficient fidelity of the product geometry. The respective algorithms that are needed to neutralize the shrinkage deformations still depend to a high extent on trial and error. This has the same drawbacks as the shaping of a geometry-specific tool and is not economical for the production of single specimens of unique geometry. An attempt was therefore made to directly laser sinter ceramic powder without its sacrificial binder. Since the resolution required for the generation of dental inlays cannot be achieved with CO_2 laser radiation, lasers with shorter wavelengths were employed. Their radiation, however, can only be absorbed by electronic excitation; therefore problems arising with the large electronic bandgap of ceramic materials had to be dealt with.

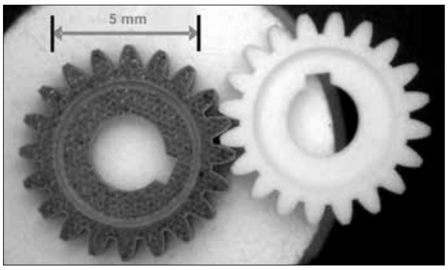

Figure 3. Functional components from an oxide ceramic powder as laser sintered (left) and after additional oven sintering (right)

Performance of laser micro sintering with oxide ceramics

By optimising the powder coating routine, the sinter strategy and choice of an appropriate laser source, bodies with an accuracy between 50 µm and 80 µm could be produced from an alumina/silica blend. The laser sintered product has a vitreous appearance and a poor pressure strength; high pressure strength and opacity were obtained only after an additional furnace sintering step, during which a shrinkage of 0.7% occurred [9]. The before and after appearance of the product is shown in figure 3.

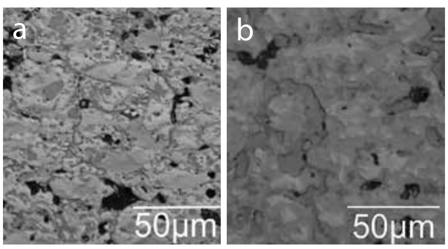

Figure 4. Cross section of an Al_2O_3/SiO_2 body as laser sintered (left) and after subsequent furnace sintering (right)

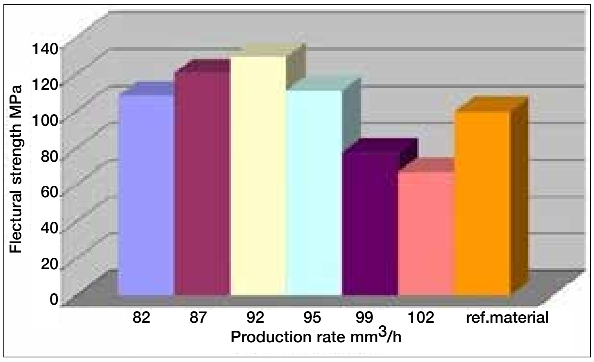

Figure 5. Flexural strength of the sintered bodies vs. production (sinter) rate.

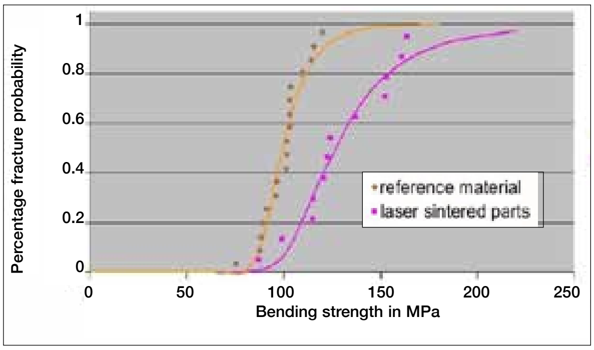

Figure 6. Weibull distribution of laser micro sintered alumina ceramics compared to reference dental feldspar material

Material properties

The porosity of the sintered material was found to be around 5% as shown in figure 4a. As expected, the pore dimensions were not significantly reduced during the final furnace sintering [figure 4b]; however, a change in the size distribution can be observed.

As shown in figures 5 and 6, the crushing and the flexural strength of the micro-sintered Al_2O_3/SiO_2 material were influenced by the process regime, but are superior to the commercial feldspar inlay ("reference") material.

Suitability for the generation of dental inlays

To test the suitability of the technique a dental inlay was generated. The scan of a cavity was amended with the data of the chewing surface that were gained via a proprietary software. The data were converted into STL-format from which the respective cross sections of the inlay for each sinter layer were calculated. The fidelity of the produced chewing surface lay within a tolerance range of 47µm.

Current economic efficiency

Considering the total size distribution of presently inserted inlays the process rate presently is one fourth of the rate that would be necessary to make the technique competitive with alternative methods. The economic efficiency can be shifted in favour of laser micro sintering if only small inlays are considered, as the time and effort is almost proportional to the volume of the inlay whereas the production times of alternative methods are to a much larger extent dominated by the surface area of the workpiece.

Summary – Acknowledgement

A technology for the freeform generation of ceramic dental inlays has been developed. One advantage it has over alternative milling techniques is that there is no tool degradation or other wear to be taken into account. Another is that the bending strength of the generated material is slightly higher than that of commercial feldspar inlay material. The

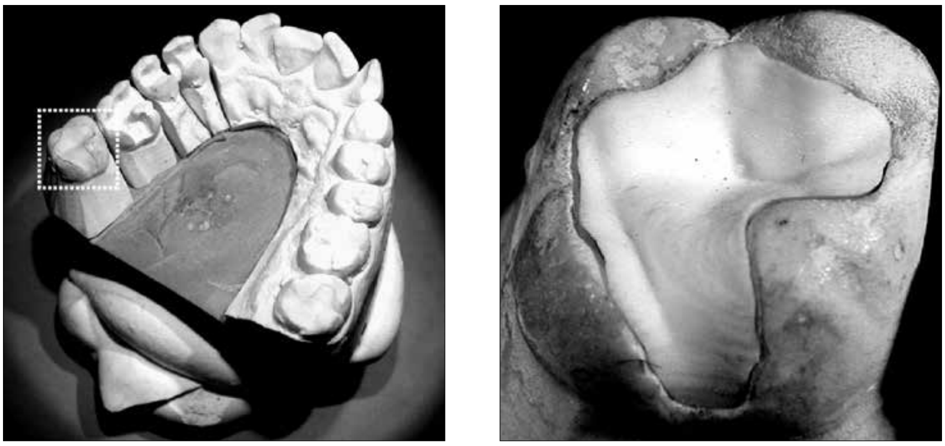

Figure 8. Laser micro sintered life size inlay of alumina/silica ceramic. The geometric data of the cavity were obtained by a scan of the replica. Cusps, fissures, and pits of the chewing surface were calculated with a proprietary software

material is chemically very inert and non-toxic. Current drawbacks are the relatively slow production rate and the lack of a dyeing procedure. The rate can be expected to increase by upgrading the laser source; a dyeing procedure has not yet been systematically investigated.

The presented results were obtained in the course of the project #9649/1464 “Verfahren zur schnellen Erzeugung von keramischen Zahn-Inlays” supported by the European fund for regional development (EFRE) 2000-2006 in the course of technology promotion and by funds of “Freistaat Sachsen” (Free State of Saxony).

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See Observations p55

Pulsed laser ablation of zirconia

Fraser Dear

Winner of the 2008 AILU Young Laser Engineer's Award

The issues involved in the laser processing of medical grade zirconia has commonalities with those of many other laser machining processes; however, specific applications and difficulties make it a problem material for our industry to handle. Not only does the material possess some unique properties but the selection of laser source used in the manufacturing process is highly application dependent i.e. one laser does not fit all.

Laser technology is still in its adolescence with respect to ceramic processing in general. It provides many advantages over its mechanical counterparts for a variety of different material processing applications but with these advantages come inherent difficulties. Zirconia has risen to become the material of choice in the biomedical implant industry but from a laser processing point of view it has not yet been fully characterised or understood. Zirconia, is a refractory ceramic and has many applications such as its use as a component in thermal barrier coatings, gas sensing and aerospace technologies.

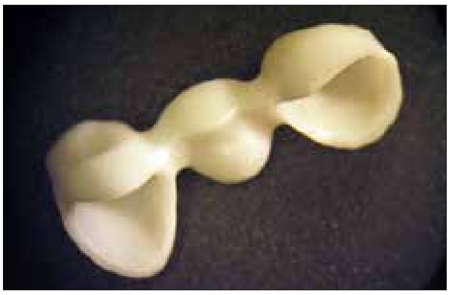

Figure 1. A mechanically machined zirconia dental bridge.

Renishaw plc has a direct interest in the dental applications of Zirconia. As a leader in production and supply of all-ceramic dental reconstructions, such as the example in figure 1, Renishaw are interested in further developing their application base for high speed and fine feature machining of medical grade zirconia, a requirement for unlimited customisation to the finished product.

Material

Zirconia is a polymorphic material that has three forms: monoclinic (M), cubic (C) and tetragonal (T). These three forms determine its structural capabilities. As a base material Zirconia is unstable and when heated during manufacture it goes through the phases in the M-T-C order:

$$\text{Monoclinic} \xrightleftharpoons{1170^\circ C} \text{Tetragonal} \xrightleftharpoons{2370^\circ C} \text{Cubic} \xrightleftharpoons{2680^\circ C} \text{Liquic}$$

During the cooling process at around 1100 °C the T-M transformation induces an increase in volume creating large internal stresses. To avoid this, small amounts of other materials such as Yttria (Y_2O_3), can be added, allowing the material to stabilise in a tetragonal form at room temperature with grain sizes of between 1 µm and 5 µm. If another stabiliser is added, magnesium for example, the resultant ceramic material exhibits very different material properties. Because this change in properties is so dramatic it is very important that the composition of the material is known. This is illustrated in the phase diagram in figure 2. Medical grade, yttria stabilised zirconia (Y-TZP) lies within the shaded region.

The material used in this particular study was supplied by C5 Medical Werks. It

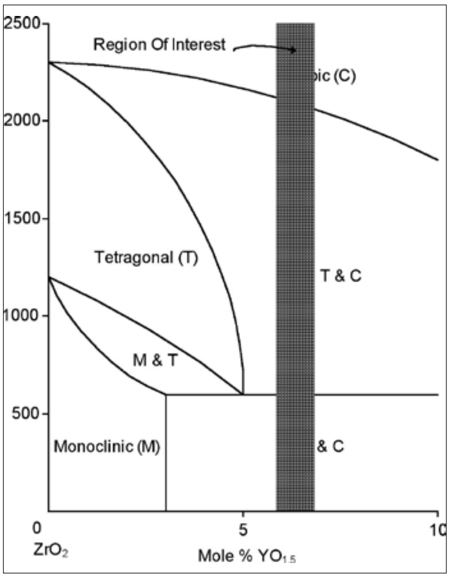

Figure 2. Zirconia-Yttria phase diagram showing the region with high Zirconia (low Yttria) content where medical grade yttria stabilised zirconia lies.

was not only stabilised with ~3% Yttria but has also undergone transformation toughening, a process that involves creating stress zone to inhibit crack propagation: a T-M phase change occurs at a crack tip, actively forcing the crack to close using the increased volume of the M phase material. This unique property in dental materials clearly increases their suitability for dental applications; they can absorb compressive stress in a way that other ceramics may not. For this reason, Yttria Stabilised Zirconia is the current material of choice for all-ceramic dental reconstructions.

Results for different laser sources

From an economic point of view, the best solution as far as laser hardware is concerned would be to have a one-laser-fits-all approach, keeping the capital costs involved as low as possible. However, due to the diverse range of types of material removal required, this does not seem possible. The unique shapes involved in the manufacture of a bridge or crown involves the removal of large volumes of material in blind hole drilling as well as through cutting and profiling; all whilst maintaining high tolerances, minimal heat affected zone (HAZ) and no cracking - a major problem in machining ceramic materials.

<u>Millisecond Nd:YAG</u>

For any laser machining system, the focused spot size or minimum beam waist helps determine the minimum feature sizes that can be machined. However, for longer pulse lasers the extent of the heat affected zone (HAZ) must be taken into account.

In the case of the GSI Lumonics JK705 Nd:YAG system the minimum spot size is ~210 µm with the standard optics. Using a millisecond process and a visible or infrared wavelength the predominant material removal method is thermal and the extent of the HAZ must be assessed.

Figure 3 shows the effect of single laser pulse during the cutting of a sample of Y-TZP by the JK705 system.

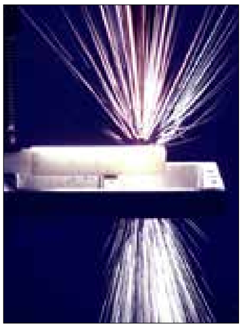

Figure 3. A 4 mm thick sample of Y-TZP Zirconia being laser machined by a single Nd:YAG laser pulse.

Figure 4 shows the typical surface produced in this way. As a result of thermal penetration a thick layer of recast material is seen to have adhered to the cracked substrate. This layer, although clearly porous and cracked, was not easily removed and therefore provided an unsuitable surface for direct dental implants. A Raman spectral analysis showed the existence of monoclinic material in the recast layer, but showed that the bulk material underneath retained its tetragonal form.

This work also showed that it is possible to remove material up to 13 mm^3/s when drilling and 2.5 mm^3/s when cutting without significant cracking, implying that this type of laser is useful for high volume material removal. An obvious application in the dental market is therefore the drilling of a blind hole in a billet as the first step in creating the internal surface of the crown or bridge. The laser could perform the 'rough' cut whilst secondary systems could facilitate the removal of the HAZ layer and any further machining required to finish the part.

Millisecond CO_2

The use of CO_2 lasers to process zirconia is well researched. Compared to the use of a Nd:YAG laser, the mechanism can be understood in terms of absorption properties of the materials at the longer wavelength that CO_2 lasers produce, which gives the laser a clear advantage with respect to optical absorption in Y-TZP. A 2.7 kW Trumpf TruFlow 2700 system was optimised to provide effective cutting of thick (8 mm) sections of

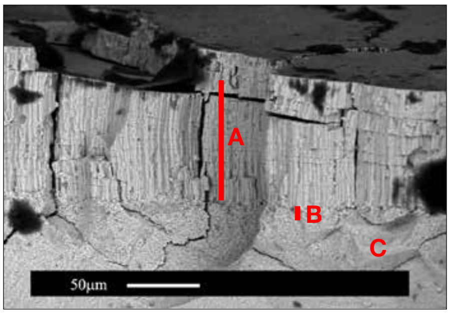

Figure 4. Re-crystallisation through thermal gradient. A : Stacked columnar structures. B : Intergranular fracture region. C : Transgranular fracture region.

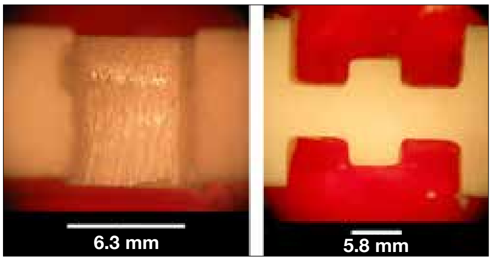

Figure 5. Images showing surface finish and bridge profile on Y-TZP, cut using a CO_2 laser.

Y-TZP along a single direction; however, as shown in figure 5, cracking was observed in the bulk when the direction was changed to provide 2-D profile cuts. Such cuts could prove to be very useful in the manufacture of dental components, as it would allow large volumes of material to be removed that would otherwise need to be mechanically removed. Although successful machining could be achieved, samples fracture remained a persistent problem.

A thermal camera inspection of the laser process revealed that as the billet was moved below the laser beam a channel of very hot material was left behind (as expected) together with a pool of molten material that adhered in small droplets to the underside of the sample. The associated high thermal gradients result in cracking in the bulk material.

Nanosecond Nd:YVO_4

The advantages associated with processing in the nanosecond (short) regime for fine-scale milling (micro-machining) is well-documented; in particular, the smaller HAZ.

In this study a commercially available nanosecond Nd:YLF system was used. In preliminary work large amounts of cracking were observed; however, after installation of high speed scanning optics, successful machining was achieved. This regime lends itself well to milling applications such as removing layers of recast material or creating fine rules and marks. With carefully chosen parameters it was possible to machine Y-TZP with no cracking in the bulk material and little observable HAZ, as shown in figure 6. Of course, working with a reduced pulse length carries the penalty of a longer processing time.

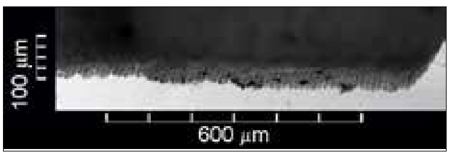

Figure 6. Nanosecond laser machining showing no cracking existing in the bulk

Millisecond Fibre

A novel process was developed with a 1kW IPG YLR1000 fibre laser which provided successful through-cutting of 18 mm thick Y-TZP samples. In this novel process, a series of holes was created across the bulk material. As each hole was drilled the thermal gradient drove a crack back to the previous hole. This technique proved to be successful at not only cutting straight lines but also 2D profiles, as can be seen in figure 7. However, monoclinic material was found in the vicinity of the cracked surface, as expected from the material response to stress, meaning that without further processing (e.g. nanosecond machining or mechanical grinding), the processed material would be unsuitable for direct dental implants.

Figure 7. Sample part machined in Y-TZP using the Nd:YVO4 nanosecond system

Summary

Successful machining of Y-TZP has been shown for each of the laser sources discussed and subsequently the differences and potential problems associated with each have been shown. The high processing speeds using millisecond Nd:YAG & CO_2 laser sources are suited only to rough cutting; whereas the Nd:YVO_4, whilst capable of machining to customer tolerances took considerably longer. The fibre laser source showed promising results for a fast and accurate laser processing.

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See Observations p55

Protective eyewear standard for Intense Pulsed Light systems

Mike Barrett

In Virtually all standards published by British Standards Institution are agreed internationally, and are either truly International (through ISO or IEC) or European (through CEN or CENELEC). So it was a rare event when last March the BSI published a British (i.e. UK-specific) standard; two in fact! This was because the concern of the relevant BSI Technical Committee (PS2/3) at the rapid introduction into the UK of Intense Pulsed Light (IPL) systems and their widespread installation in clinics and beauty salons countrywide.

IPL equipment generates high intensity broadband incoherent light usually in the visible or near infrared wavelengths. Specific wavelengths for use are selected by filters. Such systems are predominantly used in the cosmetic/beauty industry on the high street for such procedures as hair removal, the treatment of vascular and pigmented lesions and photorejuvenation (an alternative some say to the use of Botox). Although the HealthCare Commission regulates the use of this equipment through the Care Standards Act 2000 and its associated Regulations, the growth of the use of IPL systems has been, and is likely to continue to be, dramatic.

A major weaknesses with using IPL equipment is the lack of a specification for protective eyewear for operators (and others) and guidance for the use of that protective eyewear. Of course the Personal Protective Equipment Directive as applied in the UK requires workers and others to be protected and to use approved equipment for that purpose. The Standards issued in March of this year provide that specification in BS 8497-1:2008 'Eyewear for protection against intense light sources used on humans and animals for cosmetic and medical application'. Part 1 is a specification for products and part 2 is guidance on use.

Protective eyewear for intense light sources (ILS) is required to protect against excessive exposure during normal operation and foreseeable accidental exposure due to equipment malfunction or human error. The protection includes accidental and cumulative exposure and discomfort associated with viewing bright reflections. The specification covers optical radiation within the spectral range 180nm to 3000nm. (N.B. This specification is not intended to give protection against laser radiation – this is covered by the standards EN207 and EN208.)


Courtesy of FamCare Aesthetic Centre

IPL in operation

Within the body of BS 8497-1, specifications are given for the luminous transmittance and colour of the protective filters together with allowable material and surface defects, construction, labelling and user information. The requirement for active filters is also defined. Of great benefit to users is the guidance given in the informative annex of the standard which suggests methods for determining the Filter Protective Factor (FPF). The assessments can be complex as much IPL equipment has different attachment tools (applicators) to allow light of different wavelength to be emitted, depending on the procedure being conducted by the clinician. The FPF is required to be evaluated for each case, so that suitable eyewear can be selected from a manufacturer's range.

Standard BS 8497-2 gives practical guidance on the application of protective eyewear when using IPL equipment. It refers to the European Directive 2006/25/EC (the Physical Agents (Artificial Optical Radiation) Directive), which requires risk assessments to be made and for protection to be given to those within the hazard area. BS8497-2 also requires an assessment of the risk of injury from optical radiation when exposure is likely to be in excess of exposure limit values (ELV's). IPL equipment can emit a series of pulses in a broad spectrum and ELV's depend on the wavelength of the radiation, the pulse duration or exposure time, the tissue at risk and the size of the retinal image. ELV's therefore vary with the type of equipment and the optical properties of the applicator in use.


Courtesy of Pro-Lite Technology LLP

The Part 2 guidance document recommends that control measures should reduce the hazard as far as reasonably practicable by engineering controls. Personal protection should only be used when engineering and administrative controls are impracticable or incomplete. Such protective eyewear should provide comfort and clear vision taking into account the ambient lighting in the treatment environment. This standard concludes with practical examples for making assessment of the retinal thermal hazard together with further information of the filter protection factor (FPF) and luminous transmittance.

These standards are essential reading for those in control of establishments using IPL equipment and Laser Protection Advisers working in the medical/cosmetic industry. Users of IPL will probably need to seek guidance to ensure total compliance. Should the current proposals of the HealthCare Commission to de-regulate the use of Class 3B and 4 lasers together with IPL come to pass (the authors view is that this is unlikely) these standards will be vital to all clinics and high street beauty salons to ensure the current good safety record for use of this equipment. Meanwhile the standard writers are taking these standards into the International arena for global adoption.

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OBSERVATIONS

Short comments on papers in this issue

Laser-assisted micro structure fabrication by using nano-particles

Qin Hu et. al.

Great work. Laser print forming is different from nano-imprint and LIGA. Here the use of nano particles provides an opportunity for depositing various materials with a particularly pattern over a large area. The patterns seem to be quite uniform. It would be interesting to see how well these materials bond to surfaces.

Lin Li
University of Manchester

In this article the Cambridge team gives us an illustration of the future of laser micro/nano-processing for micro-system fabrication. By coupling nanotechnology with laser micro-fabrication, the applications of laser processing in 21st century technology have extended their limits.

Extensive literatures have shown that nano-particles posses unique mechanical, optical, and chemical properties. Using Ag nano-particles as the building blocks for micro-structures, the authors have made use of the fact that the melting point of Ag nano-particles is lower than the bulk material. Benefits of fabricating the tool-sets include 1) lower energy consumption during fabrication, 2) extended tool-sets' lifetime, and 3) minimum damage to the surrounding areas. The paper also explores the feasibility to make Ag nano-particle paste for pattern printing, which is a low cost, high speed and mature process.

To make the microstructures, the Cambridge team propose Laser Print Forming (LPF). Large area micro-tool stamps are fabricated by laser beam or focused ion beam (FIB). The substrate surface is coated with single layer functional nano-particles paste e.g. conductive Ag nano-particles. The stamps are pressed into the paste and micro structure patterns are transferred onto the nano-particles paste layer. Alternatively, polydimethylsioxane (PDMS) replicas can be used as stamps for imprinting the paste. In this case, after the PDMS stamp is removed, laser irradiation is applied to evaporate solvents in the paste and melt or sinter nano-particles. The main concerns of the LPF process are the proper selection of nano-particle size and concentration, and the elimination of oxidation during sintering, which would worsen the conductivity of the fabricated functional microstructures.

In a way similar to what the authors have described, this novel process can be further extended to make multi-layered structures in different functional materials. Combining laser micro-fabrication with nano-particles self-assembly can easily produce complicated micro-systems. It has great potentials in making large area hybrid micro-/nano-structures, such as the lotus leave effect, and even 3D meta-materials structures, at a low process cost.

Minghui Hong
National University of Singapore

Enhanced capabilities ... by hybridization and combination techniques

Dirk Petring

This is a very impressive article and confirms the potential of hybrid welding methods. It is my opinion that most laser welding would be better carried out as a hybrid process. The benefits for hybrid welding compared to laser welding can be summarised as:

- Much higher tolerance to fit up variations
- Much easier introduction of additional material using filler wires
- Improved process stability

The main disadvantages are the increased complexity and the increased residual stresses (and therefore possibly distortion) due to the higher input. In addition to the hybrid keyhole process described, there is significant potential for hybrid conduction welding which we are currently investigating.

The article does illustrate one of the issues in laser welding, namely how we specify the process. It is my belief that the laser processes should always be specified as intensity and interaction time. This article uses the traditional way of presenting laser processing data, i.e. laser power and travel speed. I think it is almost impossible for anyone to usefully relate the data shown here to work that they are carrying out. A topic for debate I think!

Stewart Williams
Cranfield University

This useful paper by Dirk provides a good illustration of benefits and capabilities of an integrated hybrid laser-MAG welding nozzle and a combined laser cutting and welding head developed at Fraunhofer ILT. The design of the hybrid welding nozzle combines laser and arc in a single water cooled nozzle which enables deep arc inclination. This enhances the synergic effect between laser and arc. The paper highlights the practical approaches for increasing the gap tolerance of hybrid laser-MAG welding using a simple physical model, and presents a significant amount of data on the process window and gap bridging capability for hybrid laser-MAG welding of thick section steel. It also emphasises the significance for choosing the right welding position. Welding in the horizontal position (PC) has clear advantages in terms in weld bead control and gap bridging capability over welding in the flat (PA) position. These results will be useful for industrial application of this process.

The potential of using fibre lasers for cutting is yet to be fully explored. The combined cutting and welding head has great potential in terms of reduced production cost and greater manufacture flexibility. It is interesting to note that the use of this head with a high beam quality fibre laser produces a non-linear high quality edge for achieving good weld quality in tailored blank welding. Given the ever increasing interest in high power fibre lasers and pressure on reducing fabrication cost & increasing productivity, this is a useful step-forward for this process.

Steve Shi
TWI Cambridge

To date, the vast majority of laser welding applications are enabled by good fit up achieved on thin sheet by means of clamping in a lap weld configuration or accurate shearing for butt weld configurations such as tailor welded blanks or coiled strip welding. Thicker plate for three dimensional applications such as crane booms, ship or automotive suspension components has been a greater challenge due largely to the additional cost of ensuring the dimensional accuracy required to enable good fit up of components that can not easily be 'forced' into contact.

The work described by Dirk Petring is a significant step towards increasing the versatility and extending the range of laser welding to enable the welding of thick components produced by current cutting processes. It will be interesting to see whether some of the current work on adaptive control can applied to enhance the solution.

I think that the question asked by Dirk "What is the maximum gap that can be bridged and what factors determine this limit?" is a very good one and we should also be asking the corresponding question "What is the minimum gap that can be produced and what factors determine this limit?" Full answers to these questions will enable new process routes to be devised that benefit from the reduced energy consumption, reduced distortion and increased quality of laser welding, at minimum cost.

The other aspect of the laser weld development is also impressive in as much as a penetration depth normally associated with multi-run arc welding has been achieved with the high power laser and MAG hybrid process.

The cutting and welding head is a clever tool and its ability to cut and weld components whilst they remain in position in the same clamp, would logically be the best solution to ensure total repeatability of relative head path and therefore fit up for complex shapes as described. The effect on production rate may still need to be assessed, but for high value applications this is one to note.

This work highlights some interesting solutions and we now need to rise to the challenge of implementing them within our industries.

Alan Thompson
Corus

Comparison of low power Nd:YAG and fibre laser micro-welding

Mo Naeem and Steffan Lewis

The conclusion of this paper seems to be that the (heavily refined) old technology is more versatile while the sleek new fibre is faster – where it works. There must be a lesson in there somewhere.

The recent announcement of Trumpf's intent to purchase SPI indicates that serious players think that fibres have lots of development potential. It will be interesting to see where fibres have got to when they have been worked on for as long as YAGs!

J. Peter Hancocks
Warwick University

Mo Naeem and Steffan Lewis make some good points on the benefits and difficulties of laser welding. They are, though, comparing apples and pears when writing about high peak power - low average power pulsed YAG and low ish average power CW (switched) fibre.

They make the valid point that for shiny materials such as copper and aluminium high peak power density is necessary, either from a pulsed YAG or a higher power fibre. They go on to say that pulsed lasers may be modulated to provide controlled cooling ramp down and that fibre lasers can not be modulated in this way which is not true, at least for the fibre laser that I use.

As a general point I find that setting cooling rates with ramp downs is difficult, certainly in a constantly changing job shop environment, and for many parts pre heating is a more satisfactory way of controlling cracking.

I find the fibre laser is very much easier to use than the pulsed laser when making very fine welds. We have welded foils down to 50 μm and seam welded micro tubes with 50 μm wide by 50 μm deep welds that are hermetic and (relatively) strong with not much difficulty.

They report the focal lengths of the optics used and the laser spots obtained - Fibre 160 mm and 30 μm, Pulsed 80 mm and 60 μm. In general, better beam quality allows a wider range of choices of laser spot and work-to-lens distance. Small fibre lasers tend to have better beam quality than pulsed YAGs.

The conclusion, that they are both tools for different, but overlapping, tasks and that the pulsed laser is still best for some jobs is well made.

Neil Main
Micrometric Ltd

Laser micro processing and welding in particular are growing industrial applications for lasers. The article's main focus is on the technology and in particular a comparison between their company's latest low power 100 W pulsed Nd: YAG laser (JK125P) and its 100 and 200 W single mode (SM 100 and 200) fibre lasers, when welding thin foils of SS304, Ti6Al4V, Al and copper. The authors point out that the differences in beam quality and pulsed performance of these two types of lasers, so from an application perspective one would expect each to have its particular advantages and disadvantages, and they can be regarded as complementary.

I found the article to be balanced in nature when comparing the two laser types and informative enough for a potential customer looking at investing in this technology. On a personal level as somebody who has been involved with lamp pumped Nd:YAG lasers for many years it is good to see that this technology still offers greater flexibility when trying to micro weld a range of materials.

Milan Brandt
Swinburne University, Australia

This article is very well balanced and I agree with the authors that there are some applications where fibre lasers are showing very good results in micro material processing (mainly in ablation, marking, fine cutting and very fine welding). I also agree that the lamp pumped YAG laser still has many advantages in materials like copper and aluminium and the improvements in control systems and pulse to pulse stability are making the lamp pumped YAG laser capable of more challenging applications.

New developments can be expected in fibre lasers giving different wavelengths and pulse profiles to open up new applications, also there is continuing development to improve the performance of lamp pumped YAG lasers. The best advice is to consult a laser supplier with a wide range of technologies who can be an "unbiased material processing consultant" – the application results and the capital and running costs of the laser will still give the best indication of the correct laser for each application.

Dave MacLellan
Rofin-Baasel

Welding high stiffness slot – tab ... using a high beam quality laser

Christian Walz et. al.

I must point out that the actual grade of Aluminium is crucial and needs careful attention and the main problem is the huge capital cost of the 4 kW lasers mentioned. Access to them via universities is the only possibility for the likes of me and your average reader. I would be amazed if the ease of jigging supported my experience "WITH VERY LITTLE FIXTURING EFFORT" the forces of quite small welds lead to huge stresses and the fixturing is crucial to maintain a good job. Certainly the order in which welds are done is important and when we made some scaled down box sections of a ships hull, we did the same slot linking between sheets and it still needed fixturing and tacking first.

Phil Carr
Carr's Welding Technologies Ltd.

It was a real pleasure (tinged with jealousy) reading this paper. It is a thorough investigation, well reported and with a tantalising lack of all those details that would be necessary to copy the work. But my real pleasure came from the author's use of one of the most intriguing fixturing/locating techniques that has been raised to become a practical option by precision laser cutting. That is the slot-tab method of joining sheet metal components that used to be restricted to thin tin-plate toys where the only problem was pushing all the tabs into the slots simultaneously.

On top of that they used it to produce a structure that I was trying to excite UK industry with in the late 80's – the sandwich panel. This is the metal equivalent of corrugated cardboard. It is one of the strongest panel structures that can be created. Work at UMIST had shown that a beam with this structure should be capable of supporting a distributed load of one hundred times its own weight. Even in those days the principle had been used with resistance welding to form fire-doors for offshore oil platforms and hangar doors for US aircraft carriers. Of course the ability of the CO2 laser to perform stake welding with single-sided access made it an ideal tool for the task.

The preferred geometry for the core of this "stake sandwich" was a flat-topped corrugation to give the structure some resistance to transverse shear forces. It also provided a loose tolerance to the transverse location of the weld.

This structure can be formed from a wide range of thickness and metals to produce anything: from decks and sides of a ship; from the walls of a coffer dam to a thin-wall heat exchanger; from a spherical vacuum container for liquefied natural gas tanker to a coach floor; or a railway carriage crumple zone.

Of course there were some remaining engineering problems such as control of corrosion and joining panels to surrounding support structures. Now the advent of high-power fibre lasers makes aluminium stake welding a possibility. I am sure that this technology will now have a significant future in the automobile and many other manufacturing industries.

Brooke Ward
Europtics

Case Study: Remote welding in the automotive sector

Thomas Schwoerer

This is a very interesting article, which clearly outlines how Remote Welding optics built into a compact Robot End Effector allows even greater flexibility in Robot Based Welding Installations.

Irrespective of the discussion of the relative merits of different Laser Sources – each has it own merits and place in the scheme of things - the key factor is that with a fibre delivered laser beam, and a robust and reliable programmable focusing head, this is a very exciting tool to both reduce manufacturing costs, and to increase the number of design options available to a product designer – truly allowing design for laser manufacture.

The issue of the robustness of the different remote welding heads that i have seen is a very important one, as some have certainly not been designed with maintenance in mind, nor would some be capable of surviving the demands of automotive production (for example, the VW Passat is currently built at 1154 cars per day on a 3 shift system – giving 1 cycle every 54 seconds – you need a very long Mean Time Between Failure (MTBF) and very short Mean Time to Repair (MTTR) for all the devices used in the production process to maintain this output volume (i.e. individual equipment availability of better than 98%!).

Also very relevant, because this type of remote welding is only successful with off-line programming of the focusing optics, is the type of programming software package required, as some of the heads i have seen require their own programming software package, and many have limited compatibility with proprietary CAD packages (CATIA etc.), making the offline programming very difficult and time consuming.

Much better that they use one of the proprietary off-line programming packages (RobCAD, DELMIA etc.) that work directly from models from the main CAD packages, have a lot of trained operators readily available to the end customer, and allow quick, easy and reliable off-line programming (including the quick incorporation of modifications or extra product lines into the process).

These issues have seen some of the less successful designs shaken out of the market, and has left a few successful, proven, designs to choose from.

As with all laser welded product, the biggest enemy to consistent weld quality from remote welding is unreliable and inconsistent part fit up, and the potential benefits given by remote welding have meant that it has been cost effective to put a lot of development work into achieving much better consistency and stability in pressed metal parts to ensure that they will give consistent fit up without the need for high clamp density, particularly with respect to eliminating spring back (the key source of unpredictable variability in metal to metal joints). This has been done by looking at both product design and press tool design aspects.

From a product design viewpoint, the key benefit is the ability to produce shaped welds, allowing a long weld length to be fitted into a compact area, and s and spiral shaped welds are now common – especially because castellated slip joints are frequently used, as this technique improves the consistency of fit up as well as reducing weight.

Another problem with remote welding is that it is only really successful when welding 2 metal thicknesses together, and ideally, should weld through a thinner material into a thicker material – so product design needs to take this into account when designing joints. It does, however, work well when used to weld conventional steel to one of the ultra high strength hot formed steels, such as boron steel (this joint type is used a lot in the A post (windscreen pillar) and B/C post (central door pillar) areas of the car body to ensure 5* ENCAP crash performance).

I have been involved now with a number of projects that have incorporated (or will incorporate) this type of remote welding into both bodyside assembly and body framing stations – giving amazing savings in process time and recurring costs, as well as helping product designers realise some key benefits, particularly with respect to weight, ride and handling and crash performance.

My last point about the article is that it contains a wonderful idea - the use of remote welding to produce laser dimples to give an escape for zinc vapours in a joint…… so simple and obvious – I wish I had thought of that!

Stephen Ainsworth
SJ Ainsworth Consultancy

The article illustrates very well the many potential advantages of laser welding over more conventional techniques, and its particular its application to the automotive sector. Undoubtedly these are real advantages and the flexibility of both operation in production and also in joint shape design and placement are yet to be fully exploited. The laser dimpling is an interesting technique, confirming once again that successful laser welding of zinc coated steels needs that gap, contrary to many reports otherwise.

It would have also been useful to see a cost comparison in the spot welding comparison table; ultimately cost is usually the deciding factor. It would also be worth considering the effect of not having access to a process gas side jet, so important in many laser welding applications. Shielding could also be an important factor in many other applications.

Finally, as always, fixturing, will also be an important factor in the successful use of this technique

Martin Sharp
John Moores University

Freeform fabrication of dental inlays by laser micro-sintering

Peter Regenfuss et. al.

Shapes such as this for medical applications are usually made by fused deposition modelling of selective laser sintering (non-metallic) or direct laser melting (metallic). The minimum resolution of most of these systems is around 200 μm; stereolithography can reach around 70 μm. As time goes on we see continuous and pulsed wave lasers extending the scope and flexibility of traditional processes and pulsed lasers in particular creating entirely new ones. Micro-sintering is one example of SLS being taken into a new area.

The problems associated with ceramic inlay therapy are principally fracture, degree of fit, hypersensitivity, wear, maintenance of integrity, microleakage and bond failure. The accuracy and higher bending strength of the final inlay that is reported could mean this method is going some way to reducing these problems but there are a lot of boxes still to tick.

Clinical trials will undoubtedly be required, but the process could be coming at a very opportune time. The need for a furnace sintering step makes this sound like a 'off-site' procedure which some patients may see as a backwards step, but literature reports raise concerns that CNC machining may induce surface and subsurface flaws that may adversely affect the property of dental ceramic inlays prepared by dentists themselves.

I think the real, long-term potential of rapid manufacturing techniques such as this in medicine, is if they use their unique properties further. Sintering of a different type has been accepted into dentistry for a long time as a way of creating a porous structure for implants. I wonder if a graded structure, with a porous lower surface of different composition could aid cement bondage and sealing / integrity on inlays..

With lasers and rapid manufacture rule nothing out.

Andrew Pinkerton
University of Manchester

A concise article describing an industrial application with substantial potential, both in terms of creating skilled employment but also in benefiting dental patients with quicker and cheaper dental inlays. It was encouraging to observe the emphasis placed on understanding the requirements for both a successful economic and technical application. Too often in taxpayer-funded research there is a lack of focus on resolving the economic issues that are key to the success of the research. Even practical engineering requirements, such as how to control a process in production or how to achieve economic production rates, are neglected in the quest to further purely scientific understanding.

The authors describes the effect of using different laser sources: CO_2, short wave length solid state, to Q-switched. It would have been very interesting if they had explained this further. Nevertheless, what I especially like about this paper is that it raises the questions as to what further research is required prior to the successful industrial adoption of this application.

Phil Carroll
LPW Technology

The really interesting element of this work is not in the application per se, but in the way this has driven innovation in processing techniques to eliminate the use of intergranular binders. We are becoming used to the concept of directed energy processing for additive manufacturing and orthodontics has provided one of the largest commercial markets for rapid prototyping equipment.

The use of plasma or vapour pressure (and I would be very interested to know which is the dominant effect here) to provide compaction of the powder grains is a development beyond surface melting. I suspect that there is only a relatively small processing window where this force provides enough effect to aid material consolidation but not enough for expulsion of the particulate.

Processing rates are not always critical in the commercial context, although these are the factors that are usually uppermost in the minds of manufacturing process researchers. The elimination of processing steps, or easing of quality factors, often has far greater significance than the physical deposition rate achieved. At any rate, it is usual for emerging manufacturing techniques to exhibit a manifold increase in rates or efficiencies as they mature. The incremental tailoring of energy source and material properties has, I would guess, still a long way to go here. There is a lot of current development in the field of powdered materials and a resurgence of activity in laser source work too, as the recent EC FP7 call in high brightness processing shows.

Neil Calder
Engineered Capabilities

Pulsed laser ablation of zirconia:

Fraser Dear

This excellent article on laser ablation of medical grade Yttria stabilised Zirconia (used in dental reconstructions) highlights the machining capabilities of four quite different high average power laser sources: high energy millisecond Nd:YAG, millisecond CO_2, nanosecond Nd:YVO4 and millisecond Fibre laser.

The quoted removal rates (as high as 13 mm^3s^{-1} with pulsed Nd:YAG) are very useful from the industrial viewpoint. Detrimental thermal effects resulting in crack propagation into the bulk were demonstrated with millisecond pulse processing and clearly explained in terms of the material response. Only with nanosecond pulses was micro-milling possible with optimised parameters – but with greatly reduced throughput; a common problem with lower average power systems.

I congratulate the author on such an informative article and he well deserves his achievement of AILU Young Laser Engineer Award.

Walter Perrie
LLEC, University of Liverpool

EVENT REVIEW

The article on Pulsed Laser Ablation of Zirconia by Fraser Dear, presents an interesting overview of the fabrication of dental implants, based on Ytttria Stablised Zirconia (Y-TZP), using different laser sources. Much attention is given to the trade-off between the speed of processing and the quality of the cut that is produced. I am struck how the laser sources that can machine the material quickly also produce the most cracks and largest heat affected zones. When is it ever any other way?

Reading the article, I am reminded of the issues with the production of cardiovascular stents, another medical device. For the most part, lasers are used to cut stents from a metal tube using a reactive melt shear process. As these devices are also implanted in the body the surface finish is an important consideration. From my experience, the laser cutting process has been highly optimised by laser system integrators and users; however, as the surface finish produced in the laser step requires extensive etching and polishing, I am not sure if ever the full process of laser and chemical polish has been optimised. Sometimes, I wonder would it not be better to consider a slower, more precise, laser process which would reduce the burden of subsequent polishing. To some extent, I see the same consideration applying here to Fraser's work on dental implants.

I like Fraser's approach to first consider the phase diagram of Zirconia. In most cases the quality that is attained in laser materials processing is ultimately determined by thermodynamics and phase diagrams are most useful for understanding the complex processes involved. In many cases the heating cycle generated in laser processing is extremely rapid and it is the subsequent cooling or thermalisation of the laser energy in the material that ultimately determines the quality. From a practical point of view, I see most value in using phase diagrams that plot the different phases of the material in terms of the parameters of temperature and density. Using such a diagram one can plot the evolution of the laser process in terms of the expansion of the material and the temperature to which it attains on heating and cooling. For short pulse laser processing the expansion of the material during this heating step is minimal, the material does not have time to expand as the material heats. The temperature to which the material is heated is dependent on the the energy in the pulse. The subsequent trajectory of the material system as it cools, through the different vapour, liquid, solid, cubic, tetragonal, and monoclinic phases would be most informative, if only we had all the data we need at hand to execute such analysis! Fraser's work helps by providing snap shots of the end point attained when different starting points (lasers) are used for such trajectories through the phase space of the material.

Gerard O'Connor
National Centre for Laser Applications, NUI, Galway

This informative article highlights the issues when laser processing a ceramic material, Yttria Stabilised Zirconia. This material is used in a range of industrial sectors from aerospace to medical and here the specific example given is for a dental reconstruction (dental bridge) application. It neatly presents an overview of processing using a range of different laser sources and includes details on material removal rates, tolerance, heat affected zone and any cracking, all of which are important in ceramic machining. The reader will find it concise, useful and an easy to read summary of this important sector.

Janet Folkes
Nottingham University

Fraser's thorough investigation into the laser machining of zirconia highlights the complexities and difficulties in selecting suitable laser sources and beam delivery systems for relatively unknown materials, it also introduces material form as an added variable for which consideration should be made or at least investigated.

It has been very interesting to read a short summary of what must have been a large amount of work which captures the issues associated with the laser machining of a material that has not been fully characterised and I believe that lasers could make a significant change to the manufacture of dental implants.

Neil Sykes
MetaFAB, Cardiff University

EVENTS

OCTOBER

15 Photonex (15-16)
The UK's premier photonics exhibition. NEW: Engineering Lasers exhibition area
Stoneleigh Park, Coventry
http://www.photonex.org/

16 AILU Medical Workshop
Opportunities for photonics in medical device manufacture
A half day event as part of the Photonex seminar programme
http://www.photonex.org/

10:30 - 12:30
Lasers in medicine and biophotonics
Chair: Paul Harrison, Powerlase
Mike Osborne, OpTek Systems
Seamus Murphy, Oxford Lasers 'Laser based imaging ... medical devices'
Simon Andrews, The Institute of Photonics 'Applications of photonics to life sciences'
Paul French, GERI, Liverpool John Moores University
Mike Barrett, Pro Laser 'Safety when using lasers and IPL in healthcare establishments'
14:00 - 15:40 Innovative products
Andrew King, Pacer 'Lasers for medical and diagnostic applications'
Ian Stansfield, Pro Lite 'New lasers for medical/industrial applications'
Jack Gabzdyl, SPI Lasers 'Fibre lasers for medical applications'
Bob Startup, Jenoptik 'Laser welding of plastics'

Free AILU breakfast: page 51

20 ICALEO (20-23)
Temecula, CA, USA
http://www.icaleo.org/

NOVEMBER

12 AILU Jobshop Workshop
JS08: The annual business meeting for laser job shops
TRUMPF, Luton
FULL DETAILS AND FLYER TO FOLLOW

DECEMBER

3 AILU Workshop
Laser processing of polymer, metal and ceramic composites
Advanced Materials & Technology Centre, Rotherham
FULL DETAILS AND FLYER TO FOLLOW

Lasers in medicine and biophotonics

27 August 2008 Photon08 Heriot-Watt University Edinburgh

AILU's Medical Group organised a one day event of invited speakers titled 'Lasers in medicine and biophotonics' as part of the Industry and Technology Programme at the Photon08 Conference. Duncan Hand of Heriot-Watt University, and a member of the AILU Committee, chaired the event.

The meeting was organised into three themes: laser-based medical procedures; laser-based manufacturing for medical applications; and laser-based bio-research. It was well attended and there were vibrant exchanges during the discussions.

Laser-based medical procedures
Professor Holger Lubatschowski of Laser Zentrum Hannover spoke on Refractive Surgery of the Eye with Ultrashort Laser Pulses. Ultrashort (fs) laser pulses can be used in refractive eye surgery, to create a flap in the corneal tissue, even to remodelling the curvature of the material beneath, thereby improving visual acuity. This excellent presentation set the scene for the talks that followed. The presentation of Jon Exley of Lynton titled 'Lasers and Light Sources in Aesthetic Dermatology' described how lasers are commonly used to treat a variety of cosmetic and dermatological skin conditions such as unwanted hair growth, tattoo removal and the reduction of wrinkles. John Colles of Denfotex addressed the increasing role of lasers in dentistry applications including the repair of teeth and surrounding soft tissue, the relatively new process of photo-activated disinfection and drilling teeth. John presented some impressive uses of lasers in root canal work, drilling and disinfecting of dentine tubules, allowing the dentist to produce more robust fillings and restoration work.

Laser-based manufacturing for medical applications
Jon Parry of Heriot-Watt University and Nick Jones of Renishaw PLC discussing Laser Machining of Zirconia Ceramic for Manufacture of Dental Restorations. Currently dental restorations manufactured from Y-TZP at Renishaw are machined into their final state using diamond grinding tools. Recent work focused on laser machining of Y-TZP as an alternative, or complementary process, to diamond grinding with the aim of reducing machining times and cost. Afterwards, David Richardson of the University of Southampton discussed 'Harnessing the power of light – the fibre laser revolution'. David described recent advances in high power diodes, diode-to-fibre coupling schemes and doped fibre design and fabrication, describing both CW fibre lasers and those using a MOPA architecture to achieve ultrashort pulsed fibre systems operating at the multi-100 W level with pulse energies now up to around 1 mJ. Reviewing the state-of-the-art in both CW and pulsed fibre laser systems, David outlined some of the issues limiting further power and energy scaling, and described various applications. Dermot Brabazon of Dublin City University discussed 'Fabrication of micro-fluidic channels with $Nd:YVO_4$ and CO_2 laser systems'. He described two new laser micromachining processes developed for the production of devices that are used for applications such as microfluidic lab on a chip, strain measurement, sub-micrometer cooling systems and various photonic guiding systems. Dermot has a lot of experience in the characterisation and optimisation of these processes developed in-house. Details of the systems and the high efficiency achieved from these processes were presented.

Laser-enabled bioresearch
Graham Gibson of Glasgow University discussed optical tweezers and the developments made by Glasgow University's Optics Group in 'Getting a Grip on the Micro-world'. They have developed a system with a real time interface for holographic optical tweezers in which the operator's fingertips are mapped to the positions of silica beads captured in optical traps. The beads act as the fingertips of a "microhand". This is used to manipulate objects that are otherwise impossible to control by optical trapping. High-speed video microscopy aids the measurement of sub-thermal forces between interacting cells and particles with a sensitivity of 10 femtonewtons. This method may be used to produce extremely sensitive sensors.

Tom Brown of the University of St Andrews talked about Cellular Nano-Surgery. He discussed the transfection of cellular materials, in which a DNA plasmid is injected into a cell and a protein is subsequently expressed. This is important in the Life Sciences and is an active area of research. In 2002 Tirlapur et al [1] described how to use a fs-Ti: Sapphire laser source operating around 800 nm for transfection. Using lasers offers several advantages over other methods including selected targeting, sterility, and the ability to combine them with other optical techniques such as micromanipulation and spectroscopic analysis. In his presentation, Tom discussed enhanced techniques for optical transfection by use of femtosecond lasers. Using a pseudo-Bessel beam, the critical alignment condition of the beam focus and the cell membrane can be greatly reduced allowing the development of a near alignment-free optical transfection system.

Finally, Gail McConnell from the Centre for Biophotonics at the University of Strathclyde discussed 'Lasers for single-photon and multi-photon excitation microscopy'. Gail discussed how the development of laser scanning microscope techniques for life science applications placed greater demands on laser technology. She described how it was crucial to successful and efficient imaging that the laser sources is robust, simple-to-use, provides control of temporal, spectral and spatial properties and is preferably inexpensive. Gail demonstrated an overview of her group's current photonics research with the aim of improving sources for various imaging optical techniques including confocal imaging, multi-photon flash photolysis and coherent anti-Stokes Raman scattering microscopy.

Overall the day was a great success and each meeting that goes by increases AILU's profile in the Medical area and presents new opportunities for collaboration with companies and research centres well established in the Medical arena.

Anna O'Neil
anna@ailu.org.uk

[1] U.K. Tirlapur and K. Konig, Nature, 418, pp.290-291 (2002)

See events listing for details of AILU's medical event at Photonex 16 October 2008

Preparing for change

"AILU members will find at least one Special Interest Group to provide resources to help them plan the future for their business."

Despite the torrent of negative economic data being published it should be some consolation to AILU members that manufacturing is rated least vulnerable of the key UK sectors and that lasers probably has the brightest outlook of all the manufacturing technologies.

But even if the outlook is fine for the laser community worldwide, there is no scope for complacency: organisations must review their options and plan for change. This is where AILU and in particular its Special Interest Groups (SIGs) can play an important part.

The laser job shop SIG is now well established within AILU, and in the last two years it has been joined by three other SIGs: in 2007 the Market Development SIG (kicked off with the launch of AILU's Design for Laser Manufacture web site) and the Medical SIG; and this year the Micro:Nano SIG and, coinciding with AILU's latest Photonics KTN project, the Product and Process Innovation (PPI) SIG - see news on page 1. The intention is that all AILU members will find at least one group wherein, increasingly, they will find resources to help them plan the future for their business.

I do hope this issue of the magazine raises your spirits! It has (for the third issue in a row) more pages than ever and there is much ground for optimism in the news section, with announcements of positive business and research developments including big investments in laser equipment. And together with some fascinating papers on laser welding, there are two papers on lasers in the dental sector, one on nano-scale processing and an extended letter from the Job Shop Chair: in other words, something for each the SIG's special interests!

Finally, August saw the start of AILU's monthly e-newsletter. This free publication, which mirrors this magazine, is an important development in AILU's international outreach and I hope members will continue to make suggestions as to how it can better meet their needs.

Mike Green, Editor
mike@ailu.org.uk

Editorial Policy
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The editor reserves the right to edit any submissions for space and other considerations.

Authors maintain the right to extract, in part or in whole, their material for future use.

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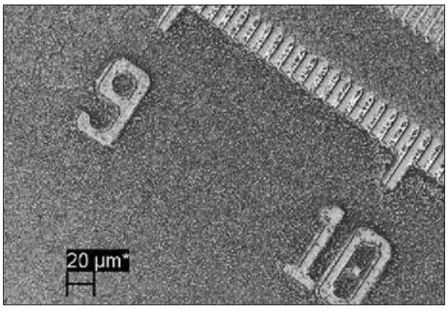

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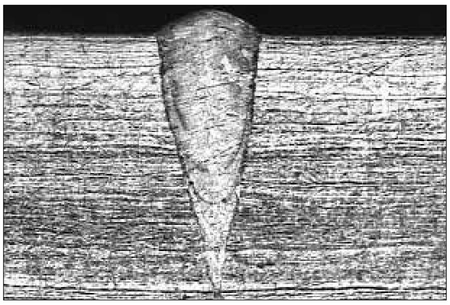
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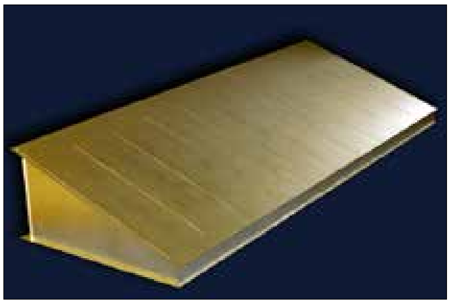
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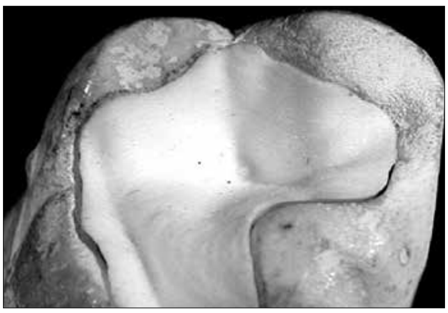
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