The Laser User

Issue 51 Summer 2008

Developments in fine and micro laser processing

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 Laser Zentrum Hannover

A component with a total width half the diameter of a hair on your head! Read about this femtosecond laser process developed at Laser Zentrum Hannover on page 44. The same group has won this quarters 'Most Gorgeous Part': see page 26. Other developments relating to micro processing can be found in the articles on pages 22, 27, 38 and 41. This quarters 'Back to Basics' piece deals fine laser cutting with pulsed laser applications.

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Discounts available to AILU Members

MEMBERS' NEWS

Association

2008 AILU Award

Jim Wright (l) presenting the 2008 Award to Tim

As reported in the previous issue of the magazine, the AILU Award for 2008 was won by Tim Weedon, in recognition of his successful pioneering efforts to introduce Nd:YAG-based machining systems into the UK and for being a tireless champion of appropriately applying laser based manufacturing.

The Award was presented at the AILU members' meeting on 8 April at Cranfield University. The presentation was made by Jim Wright, MBE who started one of the most successful Nd: YAG laser companies in the world, JK Lasers in Rugby.

"It was serendipity that brought Tim to JK Lasers," said Jim. "We weren't looking for an engineer. We weren't looking to use computers. Serendipity took the name of Maurice Clarke, a neighbour of Tim's, who had started to help industrial process development at JK after he had retired from Thorn Lighting. Maurice asked if he could show Tim round on a Saturday morning. We met, we got on, he joined, and he started working on process development with Maurice. He was the first proper engineer I got to know.'

"Then serendipity 2: Falk Strascheg, master salesman and our agent in Europe, had sold our laser, some Aerotech tables, controllers and other bits and pieces to Medtronic for welding heart pacemakers. He'd also told them that they could put it all together at JK Lasers! Tim helped them get the system working fairly quickly and as a result Medtronic purchased future complete systems from JK. We were in the systems business with Tim in charge."

Jim went on to describe Tim's involvement in the first aero engine drilling machine JK built for Rolls Royce and how it demonstrated his great engineering knowledge; his ability to fully interpret a user's needs; his commitment to meeting or exceeding user expectations; his tireless energy and enthusiasm; and his natural talent for an overall systems approach, whilst never forgetting the detail.

On the non-technical side, Jim described Tim's infectious enthusiasm and his willingness to listen, as a result of which many of his customers became friends.

Concluding, Jim proclaimed Tim as "truly the UK pioneer in the development of fully integrated YAG Laser based materials processing systems," a sentiment that was strongly supported by the audience, which included many of Tim's colleagues from the JK Laser and Lumonics eras.

In accepting the award, Tim gave a fascinating historical review of the evolution of laser machine design at JK, and thanked Jim for his kind words and for the Award. "I am most touched that so many old colleagues have come along to be part of the day, and I am very proud of the award, although in reality the award belongs to the people with whom I've had the pleasure to work," said Tim.

AILU's thanks go to Tony Paskin of Crystal Amaze (Meadowfield Shopping Centre, Sheffield) for providing the specially marked glass block and to Neil Main of Micrometric, Lincoln for manufacturing and marking the intricate stainless steel assembly for mounting the block. The citation reads 'presented to Tim Weedon in recognition of his outstanding contribution to the industrial use of lasers in the UK'.

2007 Young UK Laser Engineer's Prize

The 2008 Young Laser Engineer's Prize comprising a cheque for £275 and a laser engraved plaque (this year provided by Wayne Kilford of 3D LaserTech Ltd, Mansfield) was presented at the AILU AGM to Fraser Dear, in recognition of his successful development of fine laser machining techniques in zirconia

AILU President Clive Ireland (r) congratulating the 2008 Prize winner Fraser Dear.

Fraser (l) receiving the laser engraved plaque from his supervisor, Duncan Hand

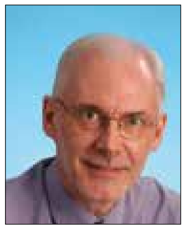
for the manufacture of tooth crowns and bridges for dental restorations.

In recommending Fraser for the AILU Prize the awards committee commented that this work was 'a perfect example of exploiting the speed and flexibility of laser materials processing for mass customisation' In the case of Fraser's work every part manufactured is different and the laser replaces a very slow diamond grinding process.

Fraser gave a fascinating presentation of his work at the AGM and a full paper is promised for the next issue of the magazine!

New AILU officers

Stewart Williams



Paul Hilton

At the AILU AGM on 8 April at Cranfield University the appointments of the committee nominations for President and Vice President were approved. Clive Ireland, having completed his year in office as President, handed over the reins to last year's Vice President Stewart Williams of Cranfield University. Stewart thanked Clive on behalf of all members for his hard work over the year and especially for making a number of important structural changes in the committee and the running of the association.

Paul Hilton of TWI, who served as AILU President in 2004/5, was re-elected as Vice President. He becomes the first past President to serve a second term.

The minutes of the AGM can be found in the documents list on the Members Area of the AILU web site. A report on other activities at the meeting in included in the events review section of this issue.

MEMBERS' NEWS

AILU web site

The AILU office has received numerous expressions of satisfaction with the appearance and layout of the new AILU web site.

The site is not yet complete but most of its planned functionality is now in place. Key active areas of the web site are the news and events pages, the products and services directory, and the user group forums. Samples are shown below.

The events pages are significantly improved. Members can have their own events added at no charge.

Fast turn around on news items, now including pictures

P&S directory listing with enhancements. Visitors can choose to email their requirements to all suppliers in a section. Members can edit their details and select new categories to appear in.

The operation of the forums in the members area has been greatly improved.

Because of its high content the AILU web site continues to enjoy an excellent web ranking for laser-related searches and members can significantly enhance their own web ranking by adding a link. For help on this and other matters please contact the AILU office.

Contact: Anna O'Neil

E: anna@ailu.org.uk.

Launch of the Micro:Nano SIG

AILU's laser micro-processing workshop held at Daresbury Laboratory on 4 June saw the launch of AILU's newest Special Interest Group (SIG), the Micro:Nano Group. Micro-processing has been a key area of activity for AILU members and significant progress in laser source technology and techniques have been made over the last decade, fuelled by the increased demand for smaller products with greater functionality and flexibility. Lasers lend themselves well to the manufacture on the micron scale, achieving yields and throughput that challenge competing techniques in an increasingly competitive and price-sensitive market.

We are delighted to announce that Malcolm Gower of Nanophoton Technologies, past AILU President, AILU Award winner and previously CEO of Exitech, has agreed to chair the Micro:Nano SIG during its initial start up.

The activities of the Micro:Nano SIG will address the interests of all manufacturers, sub-contractors and researchers across all sectors where materials processing at the micro and nano scale has a role. Members will be mailed relevant news and events information as and when we receive it and will be offered the opportunity to shape its future events. However, only AILU members can participate in discussions on the dedicated Micro:Nano forum in the members area of the website*.

For up-to-date information about the group follow the 'Laser user groups' link on the AILU site. To join the SIG simply email the AILU office.

Medical SIG runs AILU's first workshop in Ireland

AILU's first meeting in Ireland took place in Cork on 22 May 2008 and addressed laser applications in medical device manufacture. (See p 54 for details)

Two further 1-day medical meetings will take place in 2008, both in conjunction with large UK photonics events; Photon08, the biannual conference organised by the UK photonics industry, and the Photonex exhibition. Full details can be found on the AILU web site.

For up to date information follow the 'Laser user groups' link on the AILU site and to join simply email anna@ailu.org.uk.

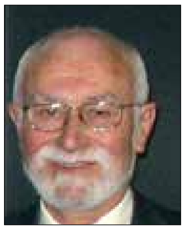
** At the time of writing its arrival on the web site is imminent*

People

Members

Three AILU members put themselves forward to join the committee. There being no other members present at the AGM who wished to nominate themselves, the three were duly appointed for a 3-year term.

Denis Hall, past winner of the AILU Award, is Director of SMI at Heriot Watt University. He is also a Director of Rofin-Sinar UK and a co-founder of PowerPhotonic Ltd.



Denis Hall

Mo Naeem is Laser Material Processing Development Manager at GSI Group, Rugby. He is a regular contributor to the AILU magazine and at AILU workshops.

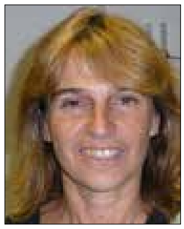
Mo Naeem

Mark Gibbons is Web Development Director at Cogitar Software, Doncaster. He is new to the laser user community but has taken a particular interest in AILU's training and web site activities.

Mark Gibbons

The fourth new member of the committee is Janet Folkes, who was co-opted after the AGM for an initial one year term.

Janet Folkes lectures in Manufacturing Engineering at the University of Nottingham and has worked in the field of laser material processing for over 25 years.



Janet Folkes

Editorial Support Wanted

Would you like to help with the publication of the AILU magazine?

We are looking for 'guest editors' to gather material for the magazine and/or help with editing and layout. If you are interested in contributing in some way please contact:

Mike Green

T: 01235 539595 E:mike@ailu.org.uk

Business

LML receives manufacturing excellence award

Julian Burt (left) and Nadeem Rizvi receiving the MNT Quality Mark from Professor Hugh Clare

Laser Micromachining Limited (LML) has been awarded the MNT Quality Mark by the Institute of Mechanical Engineers (IMechE), in recognition of the quality of service it provides to micro and nanotechnology (MNT) industries.

The award was presented by the former director of the UK's MNT Network, Professor Hugh Clare, at LML's premises within the OpTIC Technium facility in North Wales. The MNT Quality Mark recognises the fact that LML's laser micromachining capabilities have been bench-marked in a wide range of categories against best practice in both the UK and Europe and rated as 'excellent'. At the ceremony Prof. Clare stated: "These awards are recognised internationally and are given to companies who have demonstrated excellence in manufacturing. LML was subject to independent scrutiny and, in gaining the MNT Quality Mark, has demonstrated manufacturing excellence in the global supply chain".

LML provides laser-based manufacturing services to precision and high technology industries and also operates the UK Laser Micromachining Centre (UK-LMC) within the MNT Manufacturing Initiative, which is part-supported by the UK Technology Strategy Board and the Welsh Assembly Government.

"We are absolutely delighted to be receiving the MNT Quality Mark," commented LML General Manager Nadeem Rizvi. "The award will provide our industrial customers with further confidence of the competence, capability and quality of service offered by LML."

Contact: Nadeem Rizvi

E: n.rizvi@lasermicromachining.com

Rofin laser wins coveted design award at CeBIT

The Rofin DQ series of lasers manufactured by Rofin-Sinar Laser GmbH were awarded the coveted iF Design Award at the recent CeBIT information technology trade fair in Hannover, Germany. More than 2,700 products from 35 countries were asked to be considered for the prestigious award whose recipients are determined by an international jury of experts.

The external features and appearance of the DQ laser was created by Teams Design from Hamburg. Its clean design accentuates the laser's innovative technical characteristics and conveys a sense of precision and quality. The horizontal shape suggests the direction of the laser beam, which is also highlighted by a fine red line on the housing. These key design elements influenced the judging panel, which considered such criteria as design quality, choice of material, and brand value.

Rofin DQ series of lasers

The DQ series is based upon Rofin's diode-pumped Q-switched Nd:YAG laser sources and offers a range of options to meet the specific demands of individual customers and applications. Each variant of the DQ series has the option for single or dual cavities mounted within the housing. The beam delivery to the application point by fibre optics

Introduced to the market less than a year ago, the Rofin DQ series of lasers have opened up new possibilities in the field of industrial surface treatment. The first application was cleaning rail tracks on a moving train, but the laser quickly found new applications in areas such as ablating the metallic coatings of tailored blanks, creating edge isolation on solar cells and for processing of flat screens.

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Awards for Laser Optical Engineering

Philip Jaycock receiving his award from Jennette Smith for development of a corneal strain mapper

A team from Laser Optical Engineering won second prize in the Peter Smith Health Technology Innovation Awards 2007 for developing a non contact Corneal Strain Mapper. The presentation was made at a gala dinner attended by more than 100 researchers, clinicians and senior representatives from the East Midland's largest medical research organisations, hospitals and universities.

The device is now being used in St Thomas' Hospital London to investigate the best technique to use when performing refractive surgery and corneal transplantation. The results of this work should enable surgeons to both improve patient outcomes and reduce the risk of postoperative complication.

Institute of Engineering and Technology (Transport) winner

Leon Lobo and John Tyrer (second and third left) receiving their prize for the dtect system

VOL, a spin-out company of LOE, won the prestigious global award for innovation at the IET's (Institute of Engineering Technology) annual Innovation in Engineering Award Dinner held in November 2007.

VOL's dtect system was designed to develop an automated method for detecting lone drivers in car sharing lanes. After receiving the award, Prof. Tyrer said, "The receipt of an award such as this is an honour; being voted for by our peers is the highest accolade".

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The Indian economy and fibre laser cutting

The Indian Economy
Last year, as India celebrated its 60th year of Independence, all indications were that growth will continue to accelerate over the coming years at a buoyant pace. India remains on a new growth trajectory and has become a significant power on the global political and economic stage.

At the start of the present decade the division of labour between Asia's giants was distinct. China remains the world's manufacturing hub and India the world's back office for business and knowledge process outsourcing. India's services sector showed buoyant growth and contributed 56% of GDP; however, the same couldn't be said for its manufacturing. Even today India has not begun to play a significant role in global manufacturing, though compared to eight years ago things are improving and at a much faster pace. In 2006-7 Indian industry grew by 11% and manufacturing by 12%

Driven by the emergence of a vast domestic market and a supply of relatively low-cost workers with advanced technical skills, increasing numbers of multinationals are setting up manufacturing operations in India and wish to collaborate with Indian manufacturing firms either for outsourcing or to set up new plants together. Ford, Hyundai and Suzuki all export cars from India in significant numbers. ABB, Schneider, Honeywell and Siemens have set up plants to manufacture electrical and electronic products for domestic and export markets.

India's manufacturing renaissance is still in its early stages but it's already clear that it will look very different from China's. China's infrastructure and government support have smoothed the way for their manufacturers to keep ahead in global manufacturing; whereas India should focus on growing creative and innovative high tech end of manufacturing Industry, to produce relatively high value products that demands frequent value additions through innovation and creativity. This is the area of manufacturing where laser technology can become an acceptable solution in materials processing applications. It is an area that demands in depth technical knowledge of application engineering.

Introducing SLT
since its foundation in 1992 Sahajanand Laser Technology Ltd has striven to meet the needs of a growing high tech domestic market. Their major contribution to date has been to introduce high-tech CNC and laser based technology to the Indian diamond industry, helping India keep ahead in gem and jewellery production. More recently, SLT has expanded its product range to include fibre laser cutting systems for sheet metal processing, introducing them not only in India but internationally.

SLT is an ISO 9001: 2000 company with more than 400 team members and around 25 million USD turnover. It has manufacturing facilities in India and Germany, focusing on providing cutting, welding, marking and micromachining solutions in the sectors of diamond, engineering, non-conventional energy sources and sheet metal fabrication.

Laser Cutting in India
SLT Ltd has been building laser cutting machines for sheet Metal fabrication in India since 1996, including CO_2 laser systems up to 2 kW. It was a tough time in the early years with manufacturing industry sluggish and few willing to make high capital investments. Moreover, available sheet metal was not laser grade and some users faced maintenance problems as a result of not being able to work with high purity gases

Introducing fibre lasers in India
Mr. Patel started his application research into the use of fibre laser technology in 1998. Initial studies concentrated on diamond processing applications and, in 1999, simultaneously introduced this technology for laser marking and engraving applications. The enterprise was a great success for the company. Encouraged by the success of low power fibre lasers and being confident in fibre laser application engineering and technical know-how, SLT turned to cutting and other high power applications. CO_2 laser cutting machine technology was not considered to be cost effective for the Indian market in view of the frequent electricity blackouts and fluctuations, the non availability of high purity gases and good quality sheet metal, and frequent maintenance problems (such as replacement of mirrors and electromechanical parts)

As a result, SLT decided in 2002 to invest in R & D for laser cutting applications with fibre lasers. The first machine was successfully built at the end of 2003. From 2001 - 2006 Indian manufacturing industry witnessed a rapid growth and more than 100 laser cutting systems were installed but SLT decided to remain focused on fibre laser cutting system R & D and not to push for sales of CO_2 laser cutting system.

Installations
In March 2005 SLT installed it's first fibre laser cutting system (1 kW laser, Siemens controller and ball screw driven table) in a fabrication job shop near the company premises, as a pilot project. This machine continues to run 24/7 at 60-70 % capacity, cutting up to 6 mm stainless and 8 mm mild steel. The previous experience of the company was with CO_2 laser cutting machines but chose the fibre on the basis of its maintenance free operation and cost economics. Other users too have highlighted the long maintenence-free operation as a major benefit. In January 2007 STL introduced a new model with linear motors for faster cutting and positioning, and offered a 2 kW laser option.

SLT 1kW Fibre Laser with Linear Drives

Going Global
To expand their presence internationally, SLT deliver a presentation in the AILU job shop meeting in 2007 and in the same year participated in EMO Hannover as well as FABTECH, USA. Several overseas orders are in hand and the company has increased its manufacturing capability too.

Contact: Shaunak J. Dave, Sahajanand Laser Technology Ltd

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MEMBERS' NEWS

Lantek records a sharp increase in turnover
Lantek has achieved its best ever results, with a 17% increase in turnover in 2007 (to 10.2 million euro). Also, the figure of 8,000 customers worldwide was exceeded. In 2008, the company aims to increase its turnover by 22% and continue its policy of international expansion, opening new offices in Russia and Latin America and reinforcing its presence in the Baltic States, Eastern Europe and the Middle East.

A breakdown by country shows rises in turnover of 43% in Lantek Germany and 31% in Lantek UK, due largely to the boost given to sales by the company's Lantek Expert III ERP management solution, one of the main product developments in 2007.

Lantek is a global leader in the design and marketing of integral solutions in CAD/CAM and ERP for the machine tool sector. It attributes it's success in the last financial year to, amongst other things, the company's commitment to investment in R&D. In 2007 this was over 2 million euros and is supported by the three development centres it has in Alava (Spain), India and Poland.

Contact: Rob Powell
E: rob.powell@lantek-systems.co.uk

Lambda Photometrics builds on photonics success
Due to Lambda Photometrics continued success and growth in sales, Lambda's two parent companies (Physik Instrumente and Polytec) have launched their own UK operations: PI Ltd and Polytec Ltd. The two new companies are based within Lambda House and will work alongside Lambda Photometrics.

Commenting on the recent changes Adrian Harrison, Managing Director of Lambda Photometrics, said "This is great news for Lambda's customers as it means we can focus solely on our core business of sales and support of Photonics, Fibre Optics, Machine Vision and Metrology products, thereby providing our customers with the highest levels of service and support."

Lambda's complete range of products can be seen at www.lambdaphoto.co.uk

Contact: Daniel Jeffery
E: danj@lambdaphoto.co.uk

Bystronic UK at your service!
The service and after-sales support at Bystronic UK Limited has improved with the introduction of a new telephone system and services at both the Leeds and Chard offices.

There are three new telephone numbers for Bystronic UK:

T: 0844 848 5850

F: 0844 848 5851

Hotline: 0844 848 5852 for machine faults and breakdowns only.

"We have tripled the size of the hotline personnel to further improve the service we offer" said Dave Larcombe, Bystronic UK's managing director

Contact: Dave Larcombe
E: david.larcombe@bystronic.com

Laser Mech Europe relocates
Laser Mech Europe's sales offices have relocated from Destelbergen, Belgium to Mariakerke, Belgium. The new premises, a 2,500 sq./ft. facility, will house sales offices, a showroom, a training room, a meeting room and expanded warehousing for inventory.

The move is in direct response to an unprecedented growth in European sales," said Arvi Ramaswami, Managing Director of Laser Mech Europe.

Founded in 1980, Laser Mechanisms, Inc. is a recognized leader in the design and manufacture of laser beam delivery components and articulated arm systems for high power lasers, including CO_2, YAG and fibre. See the AILU web site for up to date contact details.

Contact: Arvi Ramaswami
E: arvi@lasermech.be

M-Solv expansion
M-Solv in the UK has relocated to Oxonian Park, Oxford.

M-Solv is a new and rapidly expanding high technology company. The M-Solv group of companies perform Research, Design and Manufacture of Advanced Laser Micromachining Tools applied to micro-electronics and thin film patterning applications world-wide. See the AILU web site for up to date contact details. .

Contact: Adrian Baughan
E: adrian.baughan@m-solv.com

Trumpf technology days
Following the recent debut of BendMaster press brake automation at MACH 2008, a series of technology days will be held at Luton to demonstrate the benefits of press brake automation in more detail and provide an opportunity to see the latest laser cutting and punching equipment in action.

Automated sheetmetal bending and laser cutting technology
14th to 18th July 2008

Trumpf are also holding a series of technology days designed to answer questions for anyone interested in laser welding, marking, tube cutting or formed panels or powder deposition.

Laser applications
22nd to 24th July 2008

Register on line at www.uk.trumpf.com

Contact: Gerry Jones
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Products

Sources

Pro-Lite offer Tangerine ultrafast lasers
Pro-Lite has released the Tangerine from French laser specialists Amplitude Systèms, the latest in a range of ultrafast lasers based on direct diode pumping of ytterbium doped gain materials.

Tangerine is a high average power, ultrafast fibre laser that offers a high average power and a high output energy for improved process productivity. With its high repetition rate (up to 30 MHz) and excellent beam quality, Tangerine combines the high quality needed for micromachining with the processing speed required for industrial applications.

The Tangerine offers 10ps and 700fs versions at 20W average power and sub 100fs pulses at 15W output. Pulse energies are up to 10µJ. It can be customised to special requirements.

In recognition of the advances in state-of-the-art ultrafast lasers, the Tangerine was awarded an honourable mention during the PHAST (PHotonics Applications, Systems and Technologies) Laser Focus World innovation awards.

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High power direct-diode lasers enable new applications

A high power direct-diode laser (HPDDL) is made up of a number of diode laser bars, each a monolithic array of individual diode laser emitters. Significant developments over the past decade have dramatically increased the output power, brightness and reliability of these sources: the power available from a single diode laser bar has now reached the 100 watt level at 805 nm and multiple bars can be closely packed to form a two-dimensional array in the multi-kW range with power densities up to 800 kW/cm^2, broadening their applications in several key materials processing areas.

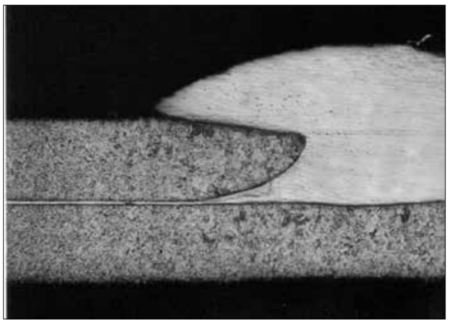
In addition to delivering high power, HPDDLs can also be directly modulated at frequencies up to 10 kHz. These characteristics, together with a documented diode lifetime of over 20,000 hours, result in HPDDL systems that provide the smallest form factor and highest power/cost ratio of any laser type. With continued advances in output power and power density, HPDDL technology is being used on a rapidly increasing basis to perform a number of common industrial tasks at higher speeds, lower cost and increased efficiency.

Welding

Applications in welding make use of the inherent rectangular output beam profile of the HPDDL, to weld a variety of metals in true conduction mode with controlled penetration. For example, a Coherent 4kW HPDDL was evaluated by one manufacturer to weld thin wall 304 stainless steel tubing. Important for the end user was the relatively small size of the laser head, which fitted within the profile of the existing tube mill without major retrofits; and that the beam size was such that no seam tracking devices were required. The conduction welds produced with this setup exhibited exceptionally smooth surfaces on both sides and very low distortion, consistent with the small heat affected zone.

Brazing

Brazing is preferred to welding in many automotive applications because the welding process for galvanized steel typically leaves the weld area susceptible to corrosion. Here the rectangular output beam profile of the HPDDL is well-suited to the linear geometry typically associated with continuous wire-

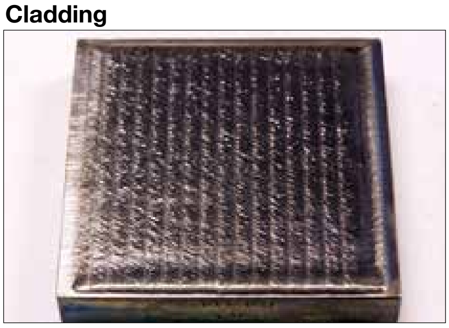


Brazing of Si-Bronze with Coherent 4kW Direct Diode Laser

feed. This simplifies process alignment, in many cases eliminating the need to integrate one or more vision systems. In addition, the rectangular line profile serves to thoroughly "wet out" the braze, yielding excellent braze bead profiles.

There are several other advantages of direct-diode brazing including significantly reduced spatter as compared to MIG, lower heat input with minimized thermal distortion and heat affected zone, and faster throughput (up to 200% faster than TIG/MIG depending on part thickness). The HPDDL seams are much smoother than typical MIG/TIG seams and do not require rework after brazing; see figure above.

Cladding



Multi-pass clad of NiCr powder material resulting in a clad 1.5 mm thick on 1018 steel plate. The clad rate was 0.45 m/min at 4 kW laser power

In cladding, the laser is used to melt a powdered metal alloy deposited onto the base material to produce a metallurgically bonded, thick, continuous layer of abrasion/corrosion resistant material. In this application, the HPDDL is displacing the CO_2 laser in part because the 805 nm wavelength associated with the HPDDL is more highly absorbed by typical industrial metals (by a factor of 2) than the longer CO_2 wavelength of 10.6 µm. The higher efficiency in melting the clad powder results in less alloy mixing than often occurs with the deeper substrate melting of the CO_2 process. Also, the HPDDL offers an electrical efficiency that is 4 - 6 times higher than that of CO_2 lasers.

The cladding shown in the figure was achieved using a Coherent 4 kW HighLight HPDDL. The output beam was rapidly scanned across the work surface in a direction perpendicular to its long axis. Overlapping passes meld together to deliver a relatively flat surface profile, regardless of processing speed.

Case Hardening

Saw-tooth tip selectively hardened using a HPDDL

Case hardening involves transforming a thin (≤ 2mm) outer layer of a metal component to produce a hard-wearing, long-life surface without introducing physical distortion or negatively impacting any of the desirable properties of the bulk metal, such as flexibility or stiffness. Laser processing offers several advantages over traditional case hardening techniques, including more rapid processing, self-quenching, precise control over case depth and minimal part distortion. HPDDL case hardening is best employed when the part has a specific, limited surface area that needs to be case hardened or if the part is so large that it is cost prohibitive to heat treat by conventional means.

As with cladding, the higher absorption of the HPDDL operating at 805 nm eliminates the requirement when using a CO_2 laser of "painting" the component with an absorptive coating prior to case hardening.

Continued advances in diode design, packaging, power, brightness and reliability will undoubtedly continue to widen the performance/cost advantage of the HPDDL over competiting laser technology and traditional techniques.

Sri Venkat and Keith Parker
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New lasers from Coherent

Diode Pumped Solid State Lasers for Solar Cell Manufacturing

Coherent, Inc. is offering three new pulsed Diode Pumped Solid State (DPSS) lasers optimized for existing and emerging laser-based processes in solar cell and module manufacturing.

Three DPSS lasers. (top) AVIA, (bottom, l to r) PRISMA and MATRIX

The three new turn-key, nanosecond pulse-duration systems are: the ultra-compact MATRIX laser offering up to 2W at 355 nm for low-power UV scribing applications; the AVIA models which now offer in excess of 23W at 355 nm and 38W at 532 nm to meet the demands of edge isolation in c-Si production lines; and the new infra-red PRISMA with 20W at 1064 nm for thin-film patterning.

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Fibre-based industrial laser delivers high power pico-second pulses

Coherent, Inc. has launched the Talisker as the world's first fibre-based laser to offer high power, picosecond output in a rugged industrial package. With over 18 watts of average power at a pulse repetition rate of 200 kHz (pulse width < 15 ps), this first fibre-based laser from Coherent will enable precision micromachining at high throughput rates with a negligible HAZ (heat affected zone). And, with a choice of infrared (1064 nm), visible (532 nm) or ultraviolet (355 nm) output, Talisker can be used on virtually any material type, including metals, polymers, glass and semiconductors. For ease of use, Talisker's internal web server simplifies remote diagnostics and preventative maintenance. The compact laser head measures only 17 cm x 39 cm x 77 cm. (See p 22 for micromachining applications of this laser)

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High Q Laser pushes p-sec power

The picoREGEN™

High Q Laser has pushed the power of their picosecond all-in-one regenerative amplifiers up to 30 W at a repetition rate of 500 kHz with the new model, the *pico*REGEN™ UC-INDUSTRIAL. The picosecond laser pulses can be triggered via TTL signals from single pulses to the maximum repetition rate of 500 kHz, providing constant energy from the first pulse onwards (i.e. no first pulse excess energy).

This new model has a footprint of just 78 cm x 34 cm, making it the most compact all-in-one picosecond amplifier on the market. It is designed for a maintenance interval of 12 months and tested to meet industrial demands. It presents high robustness and reliability and can be customized to an OEM integrators needs. It is a perfect tool for a wide range of applications in nano- and micro-processing such as solar cell structuring and scribing, thin film ablation as well as hole drilling or precision cutting. Other applications include precise ablation of metals, ceramics, semiconductors and dielectrics; wafer scribing, dicing or cutting; thin film ablation and memory repair.

The "*pico*REGEN™ comprises the resonator of the regenerative amplifier and a Pockels cell in one monolithic module, the proven High Q Laser IC (Industrial Compatible) module. The Pockels cell and its electric driver modules can both be independently replaced for an easy service in the field. It has a single 19" control unit hosting all supply and control functions for easy and true "turn-key" operation and facilitates system integration for OEM customers. The control unit also integrates the 19" liquid to air chiller.

The "*pico*REGEN™ UC-INDUSTRIAL" is optionally available with frequency doubling, tripling or quadrupling for enhanced precision.

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IPG launch high efficiency CO_2 laser

IPG Photonics, a world leader in high-power fibre lasers and amplifiers, has developed an advanced new family of CO_2 gas lasers that will allow the Company to enter new markets and applications. The first generation have output powers from 1 to 3 kW and operate at around 10.6 μm wavelength. They are claimed to be more efficient and compact than conventional CO_2 lasers now on the market.

The new gas laser family extends the tradition of innovations for which IPG's fibre lasers are well known: namely high electrical efficiency, excellent beam quality, low maintenance, ruggedness, compactness and low weight. Key features of the multi-kilowatt gas laser include an overall wall plug efficiency of 12 to 15%, low gas consumption, small size (the size of a suitcase) and low weight (approximately 120 lbs).

Fibre lasers are replacing conventional lasers including CO_2 lasers for some metal-based applications (welding, cladding, etc) but for polymers and some other organic materials processing is better using the far infrared (10 μm) output of the CO_2 lasers.

According to Dr. Valentin Gapontsev, IPG's Chief Executive Officer, "The new line of lasers feature a novel patented laser generator that allows the output power to increase without affecting the high optical quality of the beam. IPG's gas lasers are able to produce modes from TEM_{00} to TEM_{01} as well as "D" modes making them well suited for high quality and precision cutting."

"The CO_2 sealed market, growing at a rate of 6%, is estimated at more than $1 billion with 5,800 units projected worldwide in 2008," commented Gapontsev.

"Our new CO_2 laser should open up new applications because it can withstand an acceleration up to 1G, and is lightweight and compact," said Bill Shiner, IPG's Vice President of Industrial Markets. "It could, for example, be mounted on an overhead gantry for ease of delivering the laser's power to the workspace."

Customer tests of the new CO_2 laser are already lined up. IPG expects to market the new laser starting in the first quarter of 2009.

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Component handling

Aerotech's new SolarScribe for high throughput photovoltaic scribing

Aerotech has launched a new range of high precision electromechanical automation systems for laser scribing photovoltaic panels and flat panel displays. With travel up to 2.5 m, speeds to 3 m/sec and acceleration to 5 g, the SolarScribe features high performance direct-drive linear motor technology for maximum production throughput and for complete application flexibility includes a choice of air bearing and mechanical bearing systems in split axis or gantry configurations to match the customers' performance and budget requirements. The range is supplied complete with Aerotech's advanced Automation A3200 motion and machine control system that features dedicated commands such as PSO which adjust the customer's laser pulse frequency to precisely match scribing speed and dynamic position - optimising quality, and further boosting throughput performance.

Each SolarScribe includes an integrated cable management system. Multiple scanning and/or step axes, vertical and rotary correction axes along with machine base/isolation systems, and control enclosures can be added if required.

SolarScribe systems offer a choice of positioning accuracy, resolution, straightness and flatness to match the specific requirements of the PV or FPD application. The SA series use preloaded air bearing technology in a split axis configuration. The lower scan axis is firmly fixed to an isolated granite machine base and the upper step axis arranged as a gantry above. The gantry style GM series includes linear motion guide bearings with twin driven lower axes supporting the upper gantry and offers higher speed and acceleration performance with slightly less geometric accuracy than the SA.

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Measurement

Laser Lines' new portable beam profiler

Ophir-Spiricon has launched the BA150 Industrial Laser Beam Analyser. The BA150 is a compact, self-contained unit that analyses key laser parameters in order to maintain peak performance of precision material processing lasers including 1064 nm pulsed and CW industrial Nd:YAG lasers as well as diode and fibre lasers up to 150W. Because the BA150 is an integrated system there is no need for the user to add beam modifying splitters, attenuators, or other components.

Parameters measured including beam profile, average laser power, energy per pulse, pulse rate, and temporal pulse width. All measurements can be output to a PC to be recorded in digital form for storage and analysis. For process control the system can be set to flag deviations from normal beam parameters.

The BA150 is based on the new SP620 USB 2.0 Silicon CCD camera, which has been designed specifically for laser beam measurement applications. The SP620 features the highest dynamic range in the industry, up to 64dB; a programmable, high-speed electronic shutter; and a photodiode synch to capture scattered laser light at even the most challenging nanosecond pulse rates.

"The BA150 is ideal for applications where the full suite of laser beam need to be controlled," stated Ephraim Greenfield, VP Engineering, Laser Measurement Group, Ophir-Spiricon, Inc. "In YAG welding and cutting, for instance, deviation in laser beam parameters can significantly affect the quality of the work and result in extensive scrap. The BA150 is designed to improve customer yields in a compact, portable unit that measures converging and focused beams, whenever and wherever needed,"

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MEMBERS' NEWS

New measurement equipment from photonics solutions

A compact solution for characterisation of femtosecond laser pulses

APE GmbH has introduced the LX Spider, a compact and robust instrument for complete spectral and temporal characterisation of femtosecond laser pulses.

Based on a patented technology using a single crystal to up-convert the two test pulses and to introduce spectral shear without the need of an additional chirped pulse, the LX Spider measures the spectral amplitude and phase using the SPIDER (Spectral Phase Interferometry for Direct Electric-field Reconstruction) algorithm. From the spectral quantities the temporal amplitude and phase are derived in real-time.

The LX Spider operates over a wavelength range from 750 to 900nm and enables pulse characterisation down to durations of about 20fs. The device is smaller than a shoe box, portable, easy to align and operate and features automatic calibration through the click of a button.

Ocean Optics' Miniature spectrometers

Ocean Optics has introduced the Maya2000 family of high-sensitivity back-thinned 2D FFT-CCD miniature spectrometers. The un-cooled Maya2000 and the Maya2000Pro are particularly suited to low-light level applications due to their high quantum efficiency, high dynamic range and excellent UV response.

The Maya2000 family use back-thinned CCD area image sensors, a detector technology more commonly used in high-end scientific grade spectroscopy instrumentation. They offer high UV response, great signal-to-noise characteristics and wide dynamic range, making them especially suited for low light level applications. Because of their great native UV response, they do not require the applications of UV-sensitive coatings and thereby avoid the problems of batch-to-batch coating variability.

Within the Maya2000 family the USB2000+ is the fastest miniature fibre optic spectrometer that Ocean Optics have manufactured to date. Designed to monitor high-speed chemical and biochemical reactions, this spectrometer features a CCD-array detector, with high-speed USB 2.0 port interface, that can capture and store a full spectrum into memory every millisecond (i.e.1000 full spectra every second) within a wavelength band of 200 to 1100nm with resolution down to 0.35 nm (FWHM).

Jaz modular measuring suite

The Jaz modular sensing suite from Ocean Optics, consists of a community of stackable, modular and autonomous components combining to create a family of smart sensing instruments that are easily adaptable for laboratory, field or process environment. The modular components share common electronics and communications, allowing them to operate together or separately.

Distributed by Photonic Solutions PLC in the UK, the Jaz is revolutionary in its design: a powerful microprocessor and onboard OLED display eliminate the need for a PC; stackable, modular and autonomous instrument modules allow you to customise the system to your changing application needs; and Ethernet connectivity plus an SD card for data storage make remote operation routine.

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LabMax laser power meter from Pro-Lite hits the mark

Pro-Lite Technology has released the LabMax from Coherent's LMC division. The LabMax is a high-performance laser power and energy meter compatible with all Coherent thermal, photodiode and pyroelectric sensor heads. What sets it apart is its ability to capture and report every pulse at kHz rep rates, multiple data interface options and compatibility with LM-series quadrant thermopiles for beam power and position analysis.

LabMax comes in two versions: the LabMax–TO for power measurements; and the LabMax– TOP for power and energy measurements. Both meters offer wavelength coverage between 190nm to 12µm. The LabMax–TO can measure power levels between nW and kW. The LabMax–TOP can also measure energy levels from nJ to Joules. Additionally the LabMax–TOP can log the energy of every laser pulse at a maximum of 1kHz, with pulse sampling at up to 10kHz.

The beam position tool provided by LabMax in conjunction with LM series power sensors is unique, overcoming difficulties in aligning laser systems and monitoring beam pointing over time or with temperature. A quadrant sensor provides a real-time readout of the beam centroid position in the LabMax display and allows the operator to see clearly the position of the laser beam as adjustments are made to the laser resonator or beam delivery system.

The latest in the Coherent range of laser measurement instruments offers a wide range of statistical tools for anyone needing to analyse and monitor their laser's output. Data can be logged on the internal flash memory or stored on a USB flash drive attached directly to the LabMax.

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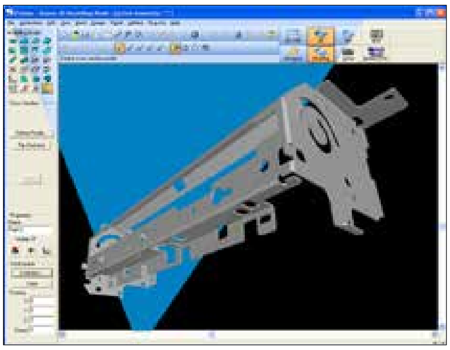
Radan 8.5 offers further improvements



Radan 8.5, the latest version of Radan Computational's CAD/CAM software for sheet metal applications in now available. Radan 8.5 incorporates a new user interface with a more familiar look and feel and a wealth of innovative functionality to maximise material utilisation and reduce cycle times.

Windows Vista compatible, Radan 8.5 enhancements include support for AutoCAD 2008.dwg files in addition to colour mapping and filtering during import; enhanced geometry and 'smart shapes' functions.

New users will benefit from the tutorial package supplied with Radan 8.5 to help familiarise them with all of its features and functionality in as short a time as possible. The handling of partly used sheets makes significant inroads into reducing material wastage. Offcuts can be automatically recorded for later use by Radan's Remnant Nesting tools and the nester evaluates all stored remnants before selecting the best one to use.

Significant enhancements to core performance ensure increased efficiency when producing NC programs for punching and profiling machines. In back-to-back testing, Radan 8.5 produced a typical part (comprising 11406 lines and arcs in 2862 complex profiles) more than 10 times faster than could be achieved in Radan 7. Further functionality includes improved support for shearing machines and pierce variants for profiling machines, resulting in ultimate control over the cutting process. As product manager Olaf Körner comments: "Radan 8.5 demonstrates our commitment to ensuring that our customers can benefit from maximised productivity."

Radan 8.5 is certified by Autodesk for its Inventor 2009 CAD software.

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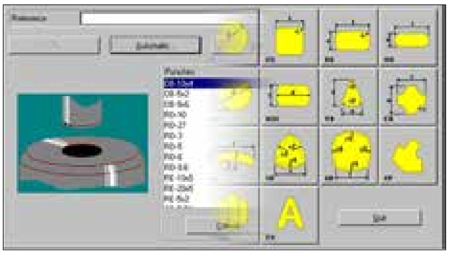
Version 27 of Lantek Expert

Lantek version 27 of its flagship product, Lantek Expert in now available. This CAD/CAM/ERP software package for cutting and punching sheet metal machine tools is a significant advance aimed at effectively meeting the requirements of customers for managing and optimising the different sheet metal manufacturing and work processes in the industrial sector.



Tool library

Lantek Expert v27 incorporates new architecture that uses advanced design and programming technologies.

Lantek Expert II

Nesting methods have been greatly improved with regard to material utilisation and processing speed. The new options give users greater control over production and easily predict the manufacturing costs and times in their factory. A completely new module for manufacturing mosaic patterns has been introduced.

Expert II generates CNC code for several different machines simultaneously from one nest, allowing companies to maximise machine utilisation through last minute changes to the production cycle.

Lantek Expert III

Version 27 of Lantek Expert III comprises a set of integrated modules (Products, Purchasing, Quotes, Manufacturing, Sales, Warehousing) which cover a company's current and future management requirements. This version is particularly significant for the new functions incorporated in the Quotation and Manufacturing modules.

The Manufacturing module incorporates new features for optimising the grouping of manufacturing operations and their integration with CAD/CAM. It also includes new reports to manage the difference between estimated costs and actual costs by part or job.

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Safety

Lasermet enhance their range of laser safety interlock systems

Lasermet, world experts in laser safety solutions, have extended their range of Laser Interlock Systems. New options offer laser users increased flexibility when ensuring that their facilities not only provide appropriate protection against hazardous lasers but also comply with best practice and the latest laser safety standards (EN954-1 (Category 3 Safety System); EN61508 (SIL4); EN61010 and EN 60947-1).

Lasermet's 2 new systems, the ICS-10 and ICS-5, are based on the well-established ICS-1 Interlock System, widely considered to be the industry standard

The ICS-10 is an intelligent version that is fully programmable from a PC. The ICS-5 is a compact system which can be wired directly to 4 interlocks or groups of interlocks, making it ideal for small laboratories or clinics. It incorporates the latest in electronic technology and is easy to install, use and maintain.

All Lasermet interlock systems have been designed for maximum safety and efficiency and are configured to provide automatic shut-off of the laser beam if safety doors, covers or blinds are opened. They are all fitted with a unique safety-checking circuit to ensure that the system is fail-safe.

These interlock systems offer the facility to interlock with laser mains power supplies, beam shutter low-voltage supplies and laser interlock connectors as well as to control the automatic switching of illuminated warning signs. A key-lock prevents unauthorised use and there is also a reset button. Emergency stop circuitry is included for activation via a push button or by breaking a glass panel.

Systems can be fitted with optional timed entry/exit overrides, generally via a push button from inside and a keypad/swipecard from outside. The system can be locked where it is imperative that there is no interruption to the laser beam.

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Flatbed cutting

Bystronic show customer machine

Stephen Davenport, managing director of Sparta Limited and Stephen Rolfe, sales director Bystronic UK Limited at MACH 2008

Bystronic UK Limited enjoyed one of its most successful MACH exhibitions with the introduction of five 'New to MACH' products, joint runner up prize at the MWP Awards and orders being placed! However, a machine ordered by Sparta Limited prior to the exhibition ended up being one of the machines on show!

At MACH 2006 long term Bystronic user Sparta Limited placed an order for the Bystronic Byspeed 5.2kW laser cutting system which was on show. In contrast this year, due to unprecedented levels of demand for machines, the company agreed that a second Byspeed 5.2 kW which they purchased shortly before MACH could be used by Bystronic on the show stand! Sparta has also recently invested in a Bystar 6kW laser cutting system equipped with rotary axis. To date the company has invested in eight Bystronic laser cutting systems in total, representing an overall investment of in excess of £2.75M with Bystronic.

Stephen Davenport, the company's managing director, comments: "Since the installation of the first Byspeed 5.2 kW machine a couple of years ago we have enjoyed a 25 per cent increase in capacity, speed and the thickness of material we are able to process. The ability to cut thicker materials has given us that unique selling point and provided us with an extra dimension to the business."

"These two latest systems actually replace three of our early, smaller Bystronic machines which have been excellent work horses and have provided thousands of hours of service. Although we have replaced three with two, we have still increased our capacity thanks to the faster cutting speeds and increased automation incorporated on the latest generation machines. Additionally, we have the benefit of increased floor space."

Mr Davenport continues: "The results we achieved with the first Byspeed 5.2 kW were phenomenal in terms of speed and accuracy. On one particular job working with 6 mm mild steel our 4 kW laser is capable of cutting 2400 mm per minute. This increased to 3500 mm per minute with the 5.2 kW resonator and with the 6 kW machine it is 4000 mm per minute, so in real terms we have halved the manufacturing time. The rotary axis gives us another unique selling point and adds to the already comprehensive list of services we offer."

"Sparta's reputation is based on the quality of products and service we provide our customers with and by ensuring lead-times are kept to a minimum and by investing in the latest technology we can be certain our reputation remains intact."

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First Bystronic for long-term laser user

Over the past six decades Thwaites Limited has become one of the UK's leading designers and manufacturers of dumper trucks. Advanced design and investment in tooling ensures its customers are provided with the very best products at the cutting edge of technology.

Thwaites has recently commissioned a Bystronic Bystar laser cutting system equipped with 6 kW resonator and a Byloader load/unload facility. A long-term user of laser equipment and a long-term user of Bystronic (Edwards Pearson) press brakes, this machine represents the company's first investment in Bystronic laser cutting technology.

Steve Trotman, Thwaites' Production and Personnel Manager takes up the story: "We needed an additional laser cutting system for increased capacity, cost-efficiency and flexibility. We were already using two 3 kW machines for our thinner gauge work as well as subcontracting out a substantial amount of laser work up to 20 mm in thickness. This 20 mm sheet and plate work was not of the right quality, as it required further downstream operations. We were not achieving the standard we as a company demand and our customers demand."

Thwaites looked at two machines – another manufacturer's recommended 4kW machine and the Bystronic Bystar 6 kW. Each machine ran a number of

trials using the same components and same materials and each company provided Thwaites with the back-up data.

Mr Trotman continues: "The machine we would choose had to be capable of cutting 20 mm and in the trials only the 6 kW machine was able to provide us with the finish we required. In addition, the Bystar represented excellent value for money - for very little more investment than the 4 kW machine we looked at, we were getting a far superior system in terms of accuracy, speed and quality of cut.

"However, having never worked with Bystronic laser cutting technology before we were nervous about choosing the machine and at the time of placing the order there was only one other 6 kW system in the country. We gave a lot of thought to the decision. Having had a long-standing relationship with David Larcombe, managing director of Bystronic UK, through Edwards Pearson for many years, we were assured that our fears, questions, problems etc would be dealt with professionally and promptly.

"The machine was delivered on time and was up and running quickly. We had to re-address the operator training but this was dealt with quickly and promptly and to-date the machine is doing everything we expected it to do and more, and has allowed us to bring all our laser sub-contract work in-house."

Seven years ago Thwaites took the decision to run their existing laser cutting systems unmanned during lights-out-production and the Bystar has slotted well into this regime, with 20 mm sheets being left to run during the night.

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Case Study

Sorb squeezes maximum benefit from laser cutting installation

SORB Engineers specialise in making the most of its resources. So when it decided to replace its two existing laser machines with a state-of-the-art automated laser cutting cell from Prima Industrie UK, the result was a customised installation delivering faster and more accurate profiling, as well as a 'lights out' capability and 40% extra material capacity than standard.

Darryl Sutton at the helm of the 4 kW Platino

Based in Marlow, Buckinghamshire for the last 42 years, SORB is a family-run company that specialises in precision sheet metal engineering and fabrication. It has established a strong reputation for quality and close attention to its customers' requirements, which is why the company's work can be found in the motor sport, medical, IT and communications sectors, in addition to more traditional markets such as machine building, architectural engineering and transportation.

"We pride ourselves on supplying excellent laser cutting and precision sheet metal services," says production manager Andy Proniw. "It's an approach that has been central to our continued business growth and is the reason we enjoy such a high proportion of repeat business." Versatility, flexibility and fast response are further factors in SORB's success. In addition, the company offers CNC folding and MIG/TIG welding facilities on site, enabling it to function as a one stop shop for its customers.

"We have always recognised the benefits of utilising technology to maintain our competitive edge," Proniw continues. "We invested in our first CNC laser cutting equipment back in 1994 and subsequently added a second, larger capacity machine from the same supplier in 1999. "Our original machine, the first of its type to be installed in the UK, provided a substantial increase in productivity over our previous punch press equipment. It enabled us to tackle much more intricate profiling jobs than before. Its ability to produce high quality work in shorter lead times allowed us to grow business levels significantly and in turn, led to the justification of the second machine.

"A further nine years down the line and it was apparent that laser cutting technology had moved on – not only in cutting speed and precision, but also in terms of work handling capabilities."

After undertaking a thorough market investigation, managing director Mike Simpson selected a solution from Prima Industrie UK. At its heart is a 4 kW Platino laser machine capable of quickly and accurately profiling up to 25 mm mild steel, 15 mm stainless steel and 10 mm thick aluminium sheet. It also provides 0.03 mm cutting accuracy across its entire machining envelope of 3 x 1.5 m while its flying optics design and high dynamics enable head speeds of up to 140 m/min and an accelerations 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 productivity, enabling us to reduce the effect of escalating raw material costs," noted business development manager David Smart. "Similarly, its inherent accuracy and repeatability has allowed us to tackle a much wider range of products than we could with the previous equipment."

The second key element in SORB's new laser installation was a purpose designed 14-storey Prima TowerServer work handling system. The unit incorporates four additional pallet stations over the standard 10-storey model and has been custom engineered to fit snugly under the 5.3 metre high roof line at SORB's premises.

Productivity Benefits

According to Simpson, the TowerServer delivers a range of productivity benefits. "First and foremost, it gives us extra flexibility. Unlike our previous machines, which needed operator input at the start and finish of each cycle to unload processed parts and position a new sheet of raw material, the TowerServer

SORB's managing director Mike Simpson controlling the automated cell

enables the Platino to run unattended. Each of the 14 shelves has a capacity of 3 tonnes and incorporates an automatic loading and unloading system. By contrast, it might have taken three or four of us up to 10 minutes to load a large sheet of, say, 15 mm material onto the previous machines. With the tower unit it is faster, safer, and allows the workforce to concentrate on skilled manufacturing tasks."

"Likewise, it enables us to handle the more complex, precision, prototyping and short lead time work during the day shift, while customers' volume requirements can be processed throughout the night under 'lights out' conditions," adds Smart.

Hand in hand with SORB's new ability to run 24/7 is the increased material stockholding and accurate recording capabilities of the TowerServer unit, which effectively transform it into an automated stores. Proniw explains that by having deliveries of raw material loaded directly onto its pallets has greatly improved health and safety.

While the installation will keep running unattended until it runs out of material or has completed all of its jobs, an additional refinement built into its offline programming capabilities enables Simpson to remotely interrogate and control the new equipment from home.

"The automation means that I can be at home and change the order of sheets being processed or the quantity, all while the machine is cutting", said Simpson. "Prima has been very responsive in tailoring the installation to our particular requirements."

The real proof of the pudding is that the company has already recorded a dramatic increase in business during the past 12 months.

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Case Study

30% cost savings for Doncaster Laser with a pre-owned laser from World Machinery

Doncaster Laser Logistics Ltd has been manufacturing laser cut components for a wide range of industries including marine, nuclear, automotive, railway and catering since 1997. Founded by Managing Director Earl Pinnock and Production Director Darren Stones, the company has expanded rapidly, recently moving to larger premises in Carcroft, near Doncaster.

As a subcontractor, the company specialises in short runs of components, between 0.5 and 20 mm thick, in mild steel, stainless steel, aluminium and Perspex. Laser cutting lends itself particularly well to low volume manufacture, allowing customers to source prototype and bespoke parts at a competitive cost.

The company has five laser machines on its Carcroft site and a further three at a sister company. Earl Pinnock explained his reasons for choosing a pre-owned LVD Axel 3015 from World Machinery (Shropshire) Ltd. "One of our existing lasers was reaching the end of its useful life and we needed a new machine to maintain production levels. At the same time we wanted to increase capacity and reduce costs."

The LVD Axel 3015 has an X-axis of 3150 mm, Y-axis of 1600 mm and Z-axis travel of 100 mm. Rapid moves can be at 170 m/min, and the cutting speed of the flying optics head up to 15 m/min. For precise cutting, positioning accuracy is 0.05 mm and repeatability within 0.02 mm. Importantly for Doncaster Laser the machine has automatic sheet loading and unloading.

"We have tried night shifts in the past, but the productivity levels we achieved made it difficult to justify," Earl Pinnock continued, "the LVD will run completely unmanned overnight, starting at 4pm and finishing at 8am the next day, enabling us to increase capacity at little extra cost." To ensure smooth running out of hours, Doncaster Laser tags all its parts into the sheet. Tagging holds each component steady in the sheet, stopping it tipping, which can jam or damage the machine. Furthermore, the

LVD 3015 at Doncaster Lasers

handling system can then move the completed sheets to an unloading area ready for the individual parts to be broken out the following morning.

World Machinery sourced the LVD Axel 3015 from Europe. The machine was then taken back to its workshops for cleaning, assembly and repair ready for demonstration to the customer. Once Earl Pinnock had chosen to buy the machine, World Machinery organised its packing and transport, and carried out the final installation and commissioning at Doncaster Laser's factory.

Earl Pinnock said, "There are only three other Axel 3015 machines in the UK, putting us in a very privileged position. The machine technology is well proven with a reputation for reliability, which is very important for 24/7 operation. Our decision to purchase a pre-owned machine was easy as this machine was a quarter of the cost of a new one. We also found World Machinery to be very helpful, delivering it in good condition and providing skilful technical support." Doncaster Laser understands laser technology and plans to carry out its own machine maintenance, so it is in a good position to judge the skills of others.

Savings on production costs are expected to be in the region of 30%, enabling Doncaster Laser to offer keener prices across all its products. The company already wins around 35% of the business it quotes for, and aims to increase this to over 40% thanks to the competitive edge provided by the LVD. Automation and overnight working will also produce an increase in capacity of around 10%. Earl Pinnock concluded, "It will be easy to sell the extra volume of components that the new machine will produce. The much lower capital investment, extra capacity and lower production costs will combine to give us payback within 12 months."

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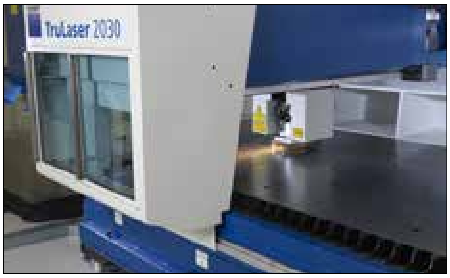
TruLaser 2030: compact but productive

The new TruLaser 2030 is engineered to be an off the shelf automated flatbed machine that synchronises the laser resonator, cutting process and automated material handling. Its integral load and unload provides a compact and highly productive flexible manufacturing cell.

Appearing for the first time in the UK, the machine employs a 3.2kW TruCoax RF excited CO_2 laser. A vacuum frame loads a blank sheet from the loading station on the cutting table, then leaves to prepare the next blank for processing. Unloading forks remove the finished parts including any sheet skeletons.



The TruLaser 2030 is available in two working area sizes: 3 x 1.25 m or 3 x 1.5 m. The Z axis movement is 115 mm. The machine accommodates a maximum sheet thickness of 12 mm.

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Tube cutting

BLM's InTube event

BLM GROUP UK Ltd's recent InTube exhibition drew visitors from across the UK to see the ease with which the company's CNC tube bending and tube forming machines can be set-up and programmed. The five-day exhibition took place at BLM's Bedfordshire premises. "The success of InTube means that a similar event focusing on tube cutting and profiling is now scheduled for later this year," said Paul Lake, Managing Director.

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Case Study

Trumpf offers road to automation

To help combat a diminishing pool of reliable labour in the northwest of England, Leyland-based subcontract fabricator Main Road Sheet Metal has ordered an automated TruLaser Tube CNC laser tube and profile cutting centre from Trumpf. The new machine will complement its Trumpf BendMaster automated bending cell, installed in September 2007.

Since its formation in 1981 Main Road Sheet Metal has enjoyed considerable growth, today occupying 80,000 sq ft across three sites in Leyland, Lancashire, from where the business turns over in the region of £4 million.

Although founded on a base of traditional sheet metal fabrication expertise, the company recognised a worrying industry trend in recent years. "It was becoming hard enough to find labour anyway, but finding reliable labour has proved very difficult in the past couple of years," says Managing Director Graham John. "It became clear that automation would make good sense."

Already a well-equipped Trumpf shop, the ISO9002-accredited company saw no reason to look elsewhere for an automated press brake, opting to install a Trumpf BendMaster automated bending cell in the autumn of 2007. The cell comprises a TruBend CNC press brake tended by a robotic sheet manipulation unit, both of which are operated by a single control and programmed jointly with TruTops Bend software.

"The cell has given us so many benefits," says Mr John. "Because we handle quite sizeable sheets, bending was previously a two-man operation – this has now been eliminated. Furthermore, we now run unmanned overnight and at weekends, which makes us even more competitive."

The installation is rare because Main Road is running a 14m ground track, the longest available. Also, because many of the sheets it processes are perforated, traditional sucker pads used by the robot to lift and manipulate the material are ineffective. To overcome the problem, Trumpf engineered a solu-

tion using magnetic grippers, one of only two such installations in the world. And despite having a capacity of 2 m x 1 m sheets, the BendMaster at the family-owned business is processing 2.8 m sheets thanks again to innovative applications engineering by Trumpf.

Aside from perforated sheet, Main Road also processes a substantial amount of tube. At present, this arrives at the Leyland facility cut to length and bundled together in stacks. With each job taking two or three operations to complete, tube stacks of work-in-progress are a common sight around the factory.

"We knew that investment in an automated tube cutter that could finish parts complete in a single set-up would reduce WIP and free up valuable floor space," explains Mr John. "The TruLaser Tube will undertake all of the necessary operations, such as drilling and trimming, and get parts ready for welding in a single hit. Cycle time and lead-time will therefore reduce and we can also take jobs away from our existing Trumpf flat bed laser, freeing up valuable capacity."

The machine, which is automatically loaded and fed, is due to ship from Germany in late April 2008. It is intended that the machine will also help Main Road fulfil a new order to supply tram frame assemblies.

"As a subcontract manufacturer we play a key role in the industry supply chain," concludes Mr John. "We have a clear vision of the way ahead and are confident of our ability to provide a competitive edge. Through a policy of continuous investment we now have extensive plant resource that equips Main Road with the production capability, flexibility and control that our customers demand."

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Laser marking and engraving

Universal's VersaLASER® series

Universal Laser Systems, Inc. has released the VersaLASER® platform series, an expansion of its desktop product line.

Designed to meet the demands ranging from one-off items to identical mass-produced parts, the series offers customers CO_2 laser power up to 60 W with a work area up to 813x457 mm.

"The VersaLASER platform series provides our customers with a broad range of entry-level, powerful, and versatile laser solutions that can process multiple materials and diverse applications with speed, accuracy, and fine feature detail," said Michael Flanary, Chief Operating Officer for Universal Laser Systems.

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Marking all-rounder

The new TruMark 3020 laser marker from Trumpf is extremely compact and versatile, a system that can be used in almost any environment. Suitable for all marking tasks in the infrared range this new model has high beam quality and high pulse peak power. It is cooled by air rather than water making it self-contained and virtually maintenance free.

Extras such as a pilot laser and optical focus adjustment can be specified but even with these additions the total laser package still weighs less than 10kg.

The scanner, laser head and power supply with hybrid cable are simply plugged in for quick and easy installation. Plug-in cards also allow modular expansion of the control system.

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MEMBERS' NEWS

Laser Intelligent Mark Positioning focuses on three key industries

The automotive, medical, and tool and die industries continually look at ways to improve their processes and quality of products and this is a perfect fit for Intelligent Mark Positioning (IMP), a technique that offers users a tool to meet or exceed their manufacturing requirements.

IMP was developed by FOBA North America. It is an integrated, through-the-lens vision system for the FOBA marking system that allows part verification, mark content and laser control to be performed under one platform. IMP reduces set-up-time, simplifies focusing, eliminates waste parts due to misaligned marks, reduces the price of costly fixturing, offers superior accurate mark placement and reduces operator errors.

A simple user interface provides all the functionality necessary to align a part with accuracy and precision. With the '3 step process' a job can be set up in less than 20 minutes and change over from one part to another in less than two. Create a job, create a layout which includes the position of the part and mark content and create a vision model to capture and identify a part. This sim-

ple set up and quick change-over equals more production time. Production part variations can be included in IMP tolerances by adjusting the tolerance levels that will ensure all parts are marked and reduce work. Teaching IMP where to place the mark will help guarantee that the mark will be positioned and oriented in the correct location thus eliminating waste due to incorrect part marking. With the programmable restricted search area IMP will search, align and mark with speed, optimising product throughput; and IMP can auto-scale to fit bigger or smaller part sizes. This option ensures that parts that are slightly bigger or smaller will be marked and will minimise re-work. On screen measurement tools allow the operator to identify the x and y co-ordinates and measure the distance or angle anywhere within the field of view, very useful for measuring the accuracy and/or precision of the pattern marked on the part. IMP's software ensures the accuracy and precision of the laser marking system and helps eliminate waste due to incorrect marking.

With the patented IMP we have taken lasers to the next level offering users their own competitive edge and generating confidence that FOBA, a Virtek company, will continually offer them products that are innovative and of high quality. As UK and Ireland distributors for FOBA, Kaye-Dee Marking Solutions have over 30 years experience of supplying, supporting and servicing both pad printing equipment and laser marking systems. With over 20 staff and on site manufacturing we are an ideal partner for all your marking, engraving and printing needs. We also distribute the high precision Swiss produced Teca-Print pad printers and quality printing inks from Ruco, Germany.

Visit www.kayedee.co.uk for information on all Kaye-Dee products and services.

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Challenges, new technology and what's ahead for Laserdyne Systems

Since the early 1980's, Laserdyne has been a leader in designing hardware and software for laser drilling cooling holes accurately and at high speeds for the aerospace industry and increasingly the land based power turbine industry. The components to be drilled are made of difficult-to-machine, heat resisting alloys and now, more frequently, include a thermal barrier coating.

Engine makers are pressing to improve fuel efficiency and reduce emissions from engines. This opens up an opportunity for Laserdyne to provide systems that produce holes in large quantities with more consistent air flow. It is also creating a growing interest in the application of laser processing for producing a new generation of shaped holes.

Improving consistently in air flow

Improving air flow is being addressed in two ways. First, Laserdyne have added features to their standard systems, based on the principal of At Focus Drilling™. By drilling at focus and then controlling the resulting hole size using the unfocused beam diameter from the laser, the process is much more tolerant to changes in the part position, and it replaces defocusing as a method for controlling hole size. Second, and possibly most important, Laserdyne are providing tools for more easily 'dialing in' the process (i.e. entering measured values of hole size or air flow) rather than on operator judgement.

Shaped holes

Shaped holes are an important design element for turbine engine designers, allowing fine-tuning the cooling of engine components. They are used sparingly today but would be utilized more widely by engine designers if the holes could be produced more efficiently and on a variety of surfaces. Shaped holes of a few specific designs have been produced on Laserdyne machines for more than five years using our BeamDirector® technology. In these cases, laser has replaced EDM, which is considered the incumbent technology for shaped hole production. However, the weakness of EDM is its slow speed and its unsuitability for thermal barrier coatings.

The story of Laserdyne's recent shaped hole development effort is somewhat parallel to what they accomplished in

the 1990's. At that time, there was a transition from combustor designs with a few hundred relatively large cylindrical holes produced on our systems to the effusion cooled combustors of today with hundreds of thousands of shallow angle holes. Laserdyne met this requirement with a new generation of systems. The next evolution in engine cooling – shaped holes – is being addressed by the generation of systems that Laserdyne are introducing now. The advances that make this possible also translate into increased production rates for conventional parts.

New products

The Laserdyne 795 brings together the many new designs and system enhancements introduced over the last nine years since the introduction of the first 790. For drilling applications, the 795 has the new CL50k ™ Nd:YAG laser, many new integrated software features, and an entirely new "look." It's an all-new system designed for the next generation's customer needs.

The Laserdyne 450 is a system designed for drilling smaller turbine engine components such as blades, nozzle guide vanes, shrouds, and heat shields. It has new features such as touch probing and onboard post processor.

A key component in both of these systems is the new S94P controller. This combination laser, sensing and motion controller has allowed our engineers to perform tasks that were impossible a few years ago.

Laserdyne design and manufacture the entire machine, including machine design, software, numerical control and laser. This allows them to introduce technology as it becomes available and to more tightly integrate the various components. The end result is process capability and control. Today's systems integrate the optics of the laser with sensors in the machine tool structure and a motion system, all optimized for the unique features of laser processing.

Reduced operator dependence

Laserdyne is making its systems less operator dependent. By adding intelligence and processes they are reducing the amount of user training and knowledge required. For example, setup of their BreakThrough Detection feature initially required the operator to perform a set up and then use the software; this was a barrier to its widespread use. An automated setup process has now been developed that allows the operator to use the feature without having to understand how it works or how to set it up.

In addition, Laserdyne has introduced new methods of training for customers. These methods include internet based short training segments and short DVD training programs in 15 and 30 minute lengths on various system features such as the S94P control. The DVD's are designed for both new and experienced operators and work in conjunction with our factory training programs. Laserdyne also make available to all customers unlimited use of our S94P simulator. This has proven to be a great training aid as well as allowing engineers to have the entire operating software available on a desk or laptop.

They have also re-introduced their annual User Group meetings, which have proved very effective for introducing users to new system features.

Problem solving

The Laserdyne Technology Center provides existing users or prospective new users access to the latest systems with a full suite of features to solve a current manufacturing need. Users of the Technology Center can program and operate these systems as if they were their own and use our Applications Engineering resources to help them work out solutions to manufacturing issues. Laserdyne's mission is to provide their customers with the finest, most productive systems available anywhere and to make the customer experience an extremely successful one.

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High speed marking for the semiconductor industry

The Rofin portfolio for the semiconductor industry includes a wide range of laser sources and turnkey solutions to many applications including IC, lead-frame and wafer marking.

High throughput from PowerLine IC-E

The PowerLine IC-E is one of a family of fully programmable IC markers, specifically designed for the semiconductor industry, which use solid state laser technology to provide high quality marking capability at high speed. This diode pumped Nd:YAG laser combines fibre technology and high speed marking heads to generate more than 1,000 characters (1.0 mm size) per second, enabling rapid processing of large batch sizes. The IC-E series lasers are able to mark even the most sensitive components and almost all materials used in semiconductor manufacturing including mould components, silicons, epoxy and ceramics etc. The available wavelengths (1064 nm and 532 nm) increase the variety of materials which can be marked.

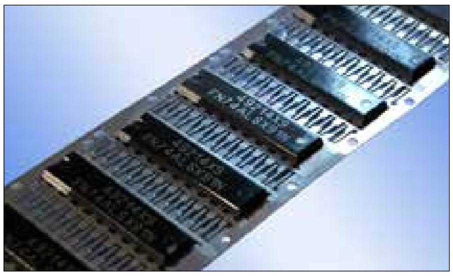
Precise performance

Precise beam power control together with high laser pulse repetition rates provides high contrast laser marking and consistent material penetration depth. Character sizes as small as 0.2 mm in height are produced with the highest quality and legibility. Line widths are selectable from 40 µm up to 160 µm and controlled penetration depths of less than 25 µm are achieved.

The high speed marking head provides a field size of 180 mm x 180 mm, and marking contents can include alphanumeric characters, logos or machine readable codes with no adverse effects on the system performance. The system comes with a powerful Windows based software package

Flexible integration and operation

The flexible technology of the PowerLine IC-E enables easy integration into either



High quality marking achieved using the PowerLine IC-E laser

new machines or existing semiconductor manufacturing lines. The compact design of the laser head and galvo marking unit means that a minimum of space is required. When the highest throughput or larger marking fields are required the IC-E is available with dual marking heads to provide an extended marking field measuring 300 mm x 180 mm.

Efficient & Reliable Technology

The PowerLine IC-E is air-cooled and designed to be efficient and economical to operate. This laser is low maintenance and up times are maximised by the long life of the diode pumped laser source.

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Laser welding

Rofin CO_2 slab lasers power the new Rofin Remote Welding System (RWS)

Rofin CO_2 slab lasers have built an enviable reputation for ease of use, high reliability and low maintenance.

The latest innovation from Rofin to incorporate CO_2 slab lasers, with their attributes of high power and excellent beam quality, is the Remote Welding System (RWS), in which the laser is mounted above the working area, on a gantry, and the laser beam delivered to the working area below by a series of mirrors. The complete system is enclosed by perimeter safety guarding allowing for safe and easy operation.

Depending upon the application, the RWS can incorporate one of a range of lasers. One option is the Rofin DC 060W, a CO_2 Slab laser with an average output power of 6 kW and beam quality factor of $M^2 \leq 1.1$. This laser can produce a spot diameter of 600 µm for the longest focal length offered of 1600 mm. The nearly perfect Gaussian beam gives a depth of focus measured in tens of millimetres and the effective working envelope of the RWS has now been increased to 1500 mm × 2000 mm, driven by the need to enhance application flexibility. Placing the beam-steering mirror on an independent high-speed linear-motor driven axis further extends the overall travel of the focusing lens thus further increasing the working envelope in the “Y” axis. This ability to determine the position of the beam steering mirror provides even greater flexibility for the operator when programming around clamping fixtures and part tooling.

The high powered motion motors, together with increased processing power in the motion controls, now gives typical indexing times of less than 50 ms between weld stitches. This improved performance is further augmented by the high power available, up to 6 kW in the case of the DC 060W, with this combination producing the highest welding speeds to date.

The rapid traverse motion between individual processing points, described as “rapid move”, sets new standards with regard to speed of operation in multiple spot weld applications, enable a considerable reduction in cycle times when compared to traditional methods of spot welding. With the capability to operate continuously on a three shift pattern, approximately 20 million welding cycles equating to more than 300 km of weld joint, can be generated without replacing any of the typical system wear parts. Traditional spot welding processes which use multiple axes and multiple spot welding guns cannot achieve these levels of efficiency and speed.

Space saving concept

The concept of mounting the laser source on a gantry above the work area means that the system occupies the minimum of floor space whilst providing a large processing area. This concept is ideally suited to applications within the automotive industry where large “body in white” components can be easily processed within the system.

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Profile Welding System from Rofin

At the beginning of April 2008, Rofin’s Macro Group showcased their Profile Welding System (PWS) at the TUBE 2008 exhibition in Dusseldorf. The Profile Welding System is a complete system designed and configured to weld tubes and profiles using fully integrated sensor technology which detects the weld gap and enables seam tracking.

Precision laser welding at high speed

Laser Welding is the perfect process for joining tubes and profiles and enables narrow seams with fine grain structure to be produced together with a minimum heat effected zone. The controlled and predictable nature of the laser welding process also means that in the majority of cases, no further heat treatment

or processing is required and the weld seams generated are capable of withstanding very high stress levels without tearing. The process is significantly faster than conventional TIG welding.

The Profile Welding System comprises of a beam guidance and sensor system together with PC-controlled linear axes. All laser system functions such as control of process gases, monitoring of the optical safety circuit and overall monitoring of the laser system and its associated cooling system are handled by the integrated PLC control system. An adaptive system ensures that the laser beam always follows the seam thus providing high process reliability and consistency. The high speed precision linear drives used by the PWS provide positional accuracies of 20 µm at production speeds of up to 60 m/minute.

Highly reliable, easy to use and virtually maintenance free

A field proven beam delivery system on the PWS is impervious to oil, dirt, dust or damp and is virtually maintenance free. For ease of use a display unit is mounted to a moveable support arm. This allows centralised monitoring and optimisation of the laser parameters and functions together with seam tracking on the work-piece.

The system can be easily configured to suit individual customer’s requirements. For example, the beam guidance system can be supplied with either a beam switch unit or a beam splitter unit for simultaneous operation on several systems (or at multiple welding points). Additional options include:-

- Process gas jets configured for the application
- A 300° rotating weld head – enabling “Drag Welding” for higher welding speeds
- Process data monitoring and storage for quality purposes
- PWS in partnership with Rofin CO_2 Slab Lasers

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Services

Job Shop

Press brakes enter Hydram sheet metalwork's fold

Hydram Sheet Metalwork has provided a laser cutting service for 10 years and to date has three Bystronic laser cutting systems with 3 x 1.5 m sheet handling capacity. The company has recently invested in two Bystronic Beyeler Xpert press brakes of 250 tonnes and 150 tonnes capacity respectively at a cost in excess of £250,000. The Xpert was shown for the first time to the UK public at the recent MACH exhibition and it is the first time Hydram has invested in Bystronic press brake technology.

The knowledge gained from Hydram's Bystronic laser cutting machines can be transferred to the bending process, for example the application of microtabs and bend relief cuts. The programming platform provides the facility to run parallel processes between the laser cutting machine and the press brake.

"The purchase of these new press brakes complete with tool handling system will further enhance our market position," said John Young, Hydram Sheet Metalwork's managing director. "Their use will minimise scrap, increase productivity and save costs – all of which are of enormous benefit to our customers."

"When it came to sourcing the new machines it was not just the quality of machine build which encouraged us to choose the Bystronic press brakes. Our experience with the company over the years has been fantastic. The after-sales service they provide, the training, their attitude to customer service, everything is similar to ours. They understand what we as the customer wants just as we understand what our customers want."

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Carlton Laser places major order

Carlton Laser Services (CLS), recently voted Supplier of the Year by the Confederation of British Metalworking, has placed an order in excess of £550,000 for a Bystronic Bystar 3015 equipped with 4.4kW resonator, rotary axis for tube cutting and the ByTrans automatic material load/unload facility.

Established in 1980 CLS has a culture for investing in the latest technology and since 1995 has invested well in excess of £2.75M with Bystronic (including this latest machine) on a range of machines which include a smaller Bystronic Bystar and a high-speed Bysprint. Both these lasers are linked to Bycell, a fully automated, compact laser manufacturing cell for up to two laser cutting systems. The sheet storage system at the centre, with over 50 storage racks, stores and administers the sheet stacks and the cut parts with skeleton. A placement/ retrieval sheet table is used to place the sheet stacks and to retrieve the cut parts. The Bytrans cross loading and unloading system loads the shuttle table of the laser system with the requested non-machined metal sheets, using the vacuum lifter, and restores the cut sheets in the cassette. They are stored either as single sheets, as a job, or in stacks.

A Pullmax 6000 FC punching system is also linked to Bycell and a Bystronic PR press brake provides a folding facility.

"We believe that the formula for our success lies in the versatility and completeness of our manufacturing processes," said Dennis Kent, CLS's managing director. "Our complimentary range of services means we can provide manufacturing to the highest quality from a single source, ensuring total control, competitive pricing and customer satisfaction."

"The Bystronic laser technology, coupled with the back-up and service provided by them during our 24-hour a day operation has enabled us to virtually guarantee our reliability and service to our customers," added Dennis. "However, when choosing this new machine the handling system was of paramount importance."

CLS's current turnover of £4.1 M is achieved by a workforce of 76 operating on three sites, all within a one-mile radius.

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Productivity gains at Laser Cutting

The team at Laser Cutting headed up by Dee Wilde have a vision; to be a premier supplier of laser cut metal components to blue chip and OEM partners. To achieve this they have a massive ongoing investment plan which will see two new automatic loading machines installed during 2008.

Dynamic Axis Flatbed with Auto loading facilities

A recent arrival, part of the ongoing investment plan, is a Trumpf 3530, a flat bed cutting system featuring a new dynamic axis and automatic on and off loading. This brings the total of machines on the shop floor to seven. "The massive benefit to our customers is that the dynamic axis machine is faster in its operation and with auto loading on and off it can be run using existing teams working on a 24 hour shift pattern," said Dee. "In essence more parts can be produced without a proportionate increase in cost of production," she added.

Roy Edwards, Purchasing Manager at Laser Cutting said, "This new machine will certainly give me a new challenge; purchasing the increased tonnage to support this new capacity, coupled with the volatility and increased prices expected in raw metal costs in this first quarter of 2008."

Laser Cutting are equally skilled in producing cost efficient tubular components as they are flat and pressed components. They have some of the widest ranges of tube laser cutting available in the UK including 2 BLM Adige Tube cutters and a Mazak Fabrigear running in 6 axis mode. This enables them to provide customers with a wide array of tubular, box, flat and sectional parts with weld prepping, where required.

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Sheffield Assay Office - out to make a mark

For anyone not familiar with the intricacies of hallmarking, it might come as something of a surprise to learn that Sheffield Assay Office, one of only four assay offices in the country appointed by Act of Parliament to test, assess and hallmark precious metal, is also a leading provider and user of laser marking technology.

But when you consider the qualities of hallmarking - accurate, precise, durable, traceable - it becomes clear why contemporary laser marking can sit comfortably alongside a very traditional craft. Indeed, as Sheffield Assay Office prepares for a move to new, purpose-built headquarters in July 2008, its laser marking facility is set to take on an even more prominent role.

Assay Master Ashley Carson explains how laser marking has become an important Assay Office service, and outlines the plans to develop it in the future.

"Sheffield Assay Office has been providing trade and consumer protection in the form of the hallmark since 1773" he says, "but some 235 years later you would expect there to be an option to the traditional method and there is - laser marking. Laser marking provides an accurate and effective option to traditional hallmarking because it does not disturb or bruise the precious metal. It is ideal for hollow, finished or intricate jewellery products, and we have found it particularly suitable for many items that now come to us from overseas as finished pieces. It's equally effective on both flat and curved surfaces and also ideal for large items which can be difficult to hold and position for traditional hallmarking. Indeed, we have had some stunning large, individual pieces in recent months for marking".

A hallmark created by laser can replicate the qualities of a struck mark, achieving 3-D deep relief at precisely the required size, position and depth, and retaining excellent definition when polished. Alternatively, the Assay Office can use a different type of laser to produce skeletal or outline laser marks, which are more suitable for hollow, semi-finished or intricate jewellery.

The benefits of laser marking as an alternative to traditional hallmarking are clear to see but the team at Sheffield

Samples of marking. (top left, clockwise) Porsche plate, Ring, Pottery, Gear knob, Cuff links, Wood

Assay Office is keen to maximise the potential of their equipment and have developed a range of business opportunities which keep the laser marking team busy.

"We have an extensive range of laser equipment, each with its own capabilities" said Jayne Stevens, Head of the Laser marking. "Laser marking is an ideal process for clearly and accurately marking a range of logos, signatures, security marks and serial numbers for decorative, promotional or engineering and industrial purposes and we have clients ranging from automotive to consumer goods manufacturers to computer ancillaries. We also have a laser development section that deals with non-production items, and a sample marking service."

The range of materials which Sheffield Assay Office can mark includes: leather, plastic, acrylic, glass, ceramics, aluminium, rubber, stainless steel, slate and wood. Indeed, Sheffield Assay Office was delighted to be commissioned to laser mark the wooden handles of a range of garden tools bearing the Duchy of Cornwall crest! They also provide laser marking for instrument controls and control panels where coatings or laminates can be removed to reveal other layers, often translucent for back-illumination.

Another source of laser marking business comes from commemorative and promotional items, such as personalised silver salvers for retirement gifts. "We have a design facility which can develop artwork for laser marking from something as basic as a rough sketch; we can scan pictures, letterheads or we can take existing artwork and format it for the laser. And we can produce anything from a simple name dedication to a very complex crest," says Ashley Carson.

Sheffield Assay Office will quote in advance for designing a programme and customers have found that laser marking is very cost effective for one-offs and prototypes, and also ideal for marking small quantities without the need for expensive tooling.

The current range of equipment includes 6 x 100 W YAG systems, 4 x 50 W YAG diode camera systems and 2 x 25 W CO_2 systems, but this is set to increase when the Assay Office moves to its new premises.

The team has also been focusing on volume production and the extra space afforded by the move, coupled with the addition of new laser equipment, will see a significant enhancement of the volume laser marking capability, which is good news for customers with volume marking requirements.

Ashley Carson is delighted with the way in which the lasermarking facility has developed and sees it as a natural partner to traditional hallmarking. So, as Sheffield Assay Office prepares to mark a new stage in its history after 235 years, his plans for the laser marking facility are clear, "We're out to make our mark with a service second to none," he says.

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MEMBERS' NEWS

High speed laser makes savings at YLF

Investment in a new high speed laser at Yorkshire Laser and Fabrication (YLF) has reduced delivery times on thinner materials and increased capacity from the same footprint.

"In the ultra competitive world that is today's sub contract laser profiling market in the UK, advancements in technology must be embraced if you are to stay ahead of the game," said YLF's Sales & Technical Director Matthew Orford. With this in mind YLF took delivery of a new Byspeed 3015 4.4 kW flat bed machine.

"The decision to buy the Byspeed was not taken lightly by the company," said Matt. "Arguably the most important reason to look for a new machine is capacity. With two laser cutting machines working around the clock it was obvious that more capacity was required, but there was little or no new space available to install a third machine and for a number of reasons we ruled out running on a second site. This left us looking for a machine that could significantly increase output over our six year old Platino.

"The benefits of high speed laser cutting are mainly with thinner materials, and as a leading UK supplier of sheet metal enclosures and assemblies we could see real advantages to our customers in terms of quality and delivery.

"Having recently bought a new Bystar 4020 4.4 kW from Bystronic in December 06 we already new how good many of the features would be on the Byspeed as many of them are shared with the Bystar. We were in production in less than three weeks from taking delivery of the first parts of the machine.

Yorkshire Laser is a family run business based in Castleford, West Yorkshire. They specialise in laser profiling and precision sheet metal work, serving companies both locally and nationally. With a range of modern lasers and sheet metal working equipment as well as in house powder coating, they are ideally placed to suit all requirements from one offs to series production.

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RE Cooke benchmarks laser cutting

An article entitled 'Analysical approach' in the May 2008 issue of Machinery magazine described how RE Cooke, a sheet metal engineering company based in Burton-on-Trent, undertook to benchmark two top-end laser cutting machines to see which was best in dealing with the type of work they undertake.

Using a series of known nests on a variety of materials up to 12 mm thick, RE Cooke asked their existing supplier and Bystronic to undertake trials using identical nests on their recommended laser cutters. The Bystronic BySpeed 3015 4.4 kW CNC laser centre proved substantially quicker in direct comparison. Quoting operations director Bruce Cresswell "The machine was undeniably quicker for thinner gauge sheet – high dynamics give increased productivity in thin material, but arguably it was no quicker in terms of linear speed when cutting thicker material. However, its positioning speed [169 m/min] and piercing capability gave it the edge."

The BySpeed 3015 also offered a better quality cut with the thin gauge sheet that RE Cooke commonly handles and allows thin sheet cutting with nitrogen, thereby eliminating oxidation on cut edges.

Quoting operations director Bruce Cresswell, "overall the BySpeed 3015 machine was 15-20% better" as a package. The BySpeed 3015 is now the centrepiece of primary processes at the Burton-upon-Trent plant.

Despite all the proven benefits, RE Cooke still insisted on a contract that only offered payment after satisfactory commissioning. Not only did Bystronic meet RE Cooke's requirements, but since installation the benefits have grown as RE Cooke have become more familiar with the machine. A step change in performance was achieved when their existing CAM/nesting software was changed to Bystronic's BySoft.

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Research

Powerlase and EUVA lead research on next generation semiconductor

Powerlase Starlase AO8 nanosecond Q-switched, diode-pumped solid state (DPSS) lasers are to be used by the Extreme Ultraviolet Lithography System Development Association (EUVA) for continued research into next generation semiconductor manufacturing.

The EUVA is working to perfect the use of discharge produced plasma (DPP) as a source for Extreme ultraviolet Lithography (EUVL). The Powerlase lasers will enable the development of the DPP source for lithography steppers, which are used for the fabrication of semiconductors. EUVL is the most likely technology to supersede current lithography techniques for high volume manufacture of semiconductors at 32nmhp and below.

DPP is one of two sources, along with laser produced plasma (LPP), capable of generating the 13.5 nm light required for successful EUVL. The Starlase lasers are the only commercial laser capable of producing the high power, high-repetition source used to ignite DPP, creating the vital 13.5 nm light and providing a more efficient manufacturing process than current lithography techniques.

Dr Samir Ellwi, Powerlase Vice President of Strategic Technology comments: "The requirement for a viable EUVL technology is becoming increasingly important, as traditional techniques reach the end of their lifespan. As such, we are very pleased to begin a new phase of research with the EUVA. The continued partnership will ensure the deadline for the creation of a 32nm technique is achieved."

Dr. Kazuaki Hotta at EUVA comments: "Powerlase are renowned for their work with high quality lasers, which make their lasers the natural choice for our DPP research."

The deal with EUVA is the latest in a string of partnerships Powerlase has undertaken in the EUVL sector. The company is currently engaged in research projects with the University of Central Florida (UCF) and University College Dublin (UCD).

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Micromachining with the Talisker picosecond laser

Until recently, picosecond lasers have largely been overlooked for industrial micromachining applications due mainly to their low average power of early picosecond lasers. The availability of industrial picosecond lasers at high average power is enabling higher resolution and superior edge quality as well as virtually eliminating the peripheral thermal effects associated with processing with longer pulses.

In the Coherent Talisker the energy of well-behaved picosecond pulses from a mode-locked fibre laser is boosted to usable levels in a robust free-space regenerative amplifier. This hybrid approach delivers the inherent stability of a fibre laser with the high energy and power handling capability of free-space amplification. The end result is a compact laser with a <15 ps pulse width, 100 microjoule pulse energy, and a repetition rate adjustable up to 200 kHz. In addition, an optional integrated harmonic module utilizes the high peak power of the near infrared (1064 nm) fundamental to generate visible (532 nm) and ultraviolet (355 nm) output with high conversion efficiency. The laser delivers high beam quality ($M^2 < 1.3$) at all three wavelengths)

Applications: Silicon Through Via (STV) Drilling

The drive for higher performance and greater functionality while also reducing size, power consumption and cost has led chip manufacturers to look at the vertical stacking of thin silicon wafers (<100 µm). The production of STVs (silicon through vias) is a key technology for vertical stacking, replacing long 2D interconnects and wire bonding with shorter vertical contacts.

The Coherent applications lab has conducted extensive tests of both percussion drilling and trepanning STVs in silicon using the picosecond output of Talisker; percussion drilling where the spot size matches the via diameter, and trepanning where a small spot cuts the via by scanning in a circular pattern.

Results for percussion drilling have shown that green and UV picosecond pulses can produce clean STVs with extremely high aspect ratio holes, as shown in figure 1. For larger spot sizes, the attainable via depth falls off quite dramatically, so the key to this process is using small spot sizes of ~10 µm. At this spot size, vias as deep as 200 µm and 5 to 15 µm wide can be drilled with a low number of pulses (around 10) and a pulse energy requirement is <25 µJ. The drilling rate can be of the order of 1500 to 1800 vias/s, or more by parallel processing by splitting the 100 µJ maximum pulse energy.

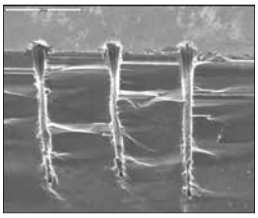

Figure 1. High aspect ratio, percussion drilled hole in silicon drilled with 532 nm pulses.

In addition to small diameter STVs, there is also a growing requirement in microelectronics for STVs with very high quality sidewalls. Coherent have shown that extremely smooth sidewalls can be produced in silicon with picosecond lasers with wavelengths of 1064 nm, 532 nm and 355 nm.

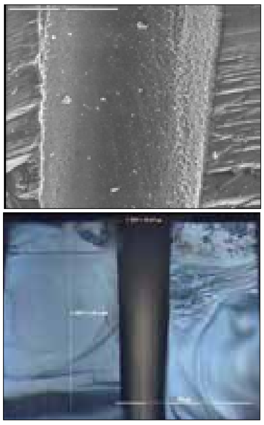

Figure 2. Trepanned hole in silicon using 355 nm pulses.

Figure 2 shows a trepanned hole in silicon using 355 nm pulses. A lower throughput is required than for percussion drilling and deeper vias can be drilled at 355 and 532 nm than 1064 nm due to the higher absorption of silicon

Thin Film Removal

The general trend of increased miniaturization in electronics is also manifesting in the use of ever thinner films. Standout examples include transparent conductive oxides used to form the front surface circuitry in flat panel displays and solar cells. Other applications included thin (tens of nm) metal films on plastic and glass substrates that are patterned to form high-density circuits for end products such as RFID cards and disposable medical sensors. Long pulse lasers currently service these scribing and patterning applications, but these can sometimes damage the underlying substrate. And with thinner films, long pulse lasers can even cause delamination or edge peel at the cut edge of the film. We have now shown that Talisker's picosecond pulses can be used to selectively remove thin films from the carrier substrate with little or no damage to the underlying substrate. For example, figure 3 demonstrates the removal of 20 nm aluminium from a glass substrate using 1064 nm, 1 µJ pulses with a focused spot size of 20 µm. The galvanometer scan speed for complete thin film removal is 3 m/s, confirming the ability to support high speed processes. The scan speed in these examples was chosen so that Talisker's high repetition rate would result in a scalloped profile, which clearly highlights the laser's circular beam profile. Moreover, generating this scalloped profile is particularly desirable in certain solar applications.

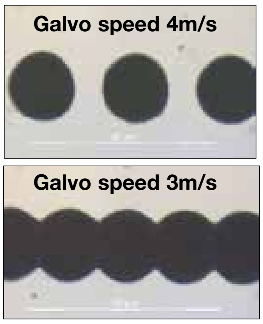

Figure 3. 1064 nm scribing of 20 nm aluminum on glass Galvo speed 4m/s Galvo speed 3m/s

Other Applications

We have evaluated Talisker in numerous other micromachining applications at Coherent and in the field. Examples include novel glass products, biodegradable plastics in next-generation stents, patterning and other surface effects in metal substrates, and creating anticounterfeit masks. Medical stents represent another application where picosecond lasers can make an impact.

Conclusion

It has long been recognized that picosecond laser pulses can produce unique and desirable results in a variety of micromachining and micro-materials processing applications. Now, the development of a source based on a fibre oscillator and a free-space amplifier offers a more robust, compact and reliable route to achieving picosecond pulses than ever before. The unique performance and reliability characteristics of the Talisker laser supports the miniaturization trends driving many industries, including semiconductor electronics, displays and medical devices.

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MEMBERS' NEWS

Institute of Physics responds
On 30 April the House of Commons' Innovation, Universities, Science and Skills Committee published a report on its investigation into Science Budget Allocations and, in particular, the financial crisis that has engulfed the Science and Technology Facilities Council (STFC) since their budget for 2008 to 2011 was announced in November 2007.

In response to the report Professor Peter Main, director of education and science at the Institute of Physics (IOP), said that the Committee has done a good job of understanding a very complicated series of events and that he was pleased that they had supported the call for a moratorium on making cuts to the physics base before the Wakeham review reports in September. It is now up to DIUS to clarify whether the Wakeham Review will address the issues affecting STFC, and for DIUS and STFC to agree arrangements which will allow substantive changes to be delayed.

"I believe the Committee is right to identify poor communication and lack of consultation as key factors which have contributed to the community's concerns," he said. "For our members, decisions which radically affect their research programmes – and indeed their jobs – were announced with little prior warning or discussion.

"There is one significant omission in the report - safeguarding fundamental physics research against international currency fluctuations. At present the funds available to support researchers are exposed to short-term international currency fluctuations. This has compounded the funding issues for STFC because a significant proportion of their money is tied up in international partnerships.

"The important thing now is for DIUS and STFC to regain the confidence of the physics community, by learning from recent mistakes and making their future intentions clear. Only with real honesty about events since the formation of STFC and more considered methods for consultation in the future, will we be able to reconstruct prosperous working relations," he concluded.

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Opportunities for UK companies in E-ELT construction

The UK Astronomy Technology Centre (UK-ATC) is the national centre for astronomical technology. It designs and builds instruments for many of the world's major telescopes. It also project-manages UK and international collaborations.

In July the UK-ATC is running national and regional meetings to cover opportunities for companies in the area of E-Extra Large Telescope (E-ELT) design. The main bulk of the research and development is going to be in civil and mechanical engineering but there are some opportunities for suppliers of optical coating plant (at the telescope site) and also optical systems (laser guide star systems, adaptive mirrors etc.). The main optics-related research will be conducted through the instrument programmes and is outside the scope of these meetings. Dates and venues for these meetings can be found on the news pages on the AILU web site.

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New BLZ user handbook
The Bavarian Laser Centre has published a new volume in the series of BLZ User Handbooks:

"Ultrashort Pulse Lasers - Basic Principles and Applications" can be ordered on the BLZ home page for EURO 24.90 (plus shipping and bank transfer charges where necessary).

The aim of the handbook series is to illustrate the basic principles of photonic technologies and their fascinating applications. Each volume of the series addresses one specific topic. The handbooks provide a first insight into the respective topics using simplified illustrations and formulae.

The intention of the handbook series is to help users apply laser technology in order to find innovative solutions to their challenges.

More information and an order form can be found on the Bayerisches Laserzentrum web site:
http://www.blz.org/

Greatest Cock-up

Dave Connaway, who runs Cirrus Laser, a laser job shop, shares some memories of customer cock-ups

Recently the designer of TV scenery arrived with a colleague in a small estate car to collect the brass pieces we had cut.

Now you would have thought that the designer of the parts would have some realisation of what size of vehicle would be required to take parts that exactly fit into 2440 x 1000 mm sheets of 0.7 mm brass carefully laid down and protected on 2500 x 1100 mm pallets. Oh no!

A small estate car was not the sort of vehicle needed and although they took some other smaller parts in the car they were back a few days later with a larger Transit panel van.

Then there was the customer some years ago that came to collect his goods from London in a Fiat Cinquecento with a roof rack.

We had laser cut from 2500 x 1250 mm sheets of 3 mm and 5 mm thick stainless steel a lot of parts almost the length of a sheet. These parts were stacked on a 2500 x 1250 mm wood pallet.

I drove the fork lift, so it's no tale, and loaded the pallet onto the roof rack of the Cinquecento. The pallet was longer and considerably wider than the vehicle and still the customer insisted that he would take the parts back to London. Ten minutes and lots of string later they set-off to reach the M23. I just hope that they didn't meet a motorway traffic cop - he would have thrown the book at them!

The AILU INTERVIEW

A university working with industry

Interview with Lin Li

Professor Lin Li, Director of Laser Processing Research Centre at the University of Manchester responds to questions sent in by AILU members

How could technology transfer from academia to industry be improved; in particular in terms of success rate and the time to market? Where do you see the way forward for effective university - industry collaboration?

The Universities have different outputs and measure of success from those for industry. Our main products are graduates, publications (and citations), patents, services to the public including government bodies, and of course technology transfers to industry. The latter is weak in the UK compared with Germany, USA, Finland and some other countries.

Over the last 10 years, the Laser Processing Research Centre at Manchester University has produced 17 PhDs, over 300 publications, 15 patents and has trained over 1000 undergraduates and MSc students in laser processing technology as part of their Mechanical and Aerospace Engineering degrees. Many of our research projects have industrial collaborators. Over the last 10 years, we have collaborated with over 50 companies.

The type of research at universities is mainly on the Technology Readiness Levels (TRLs) of 1-3. They will require further investments and developments to move them to TRL9. Laser processing technology requires high capital investments and it is primarily for this reason that end user industries have been reluctant to move forward from TRL3. The university facilities are mainly there for research and training; they are not production machines.

From TRL4, the technology development needs to be in an industrial or semi-industrial environment using industrial production machines for real components. And the problems to be addressed are completely different: issues of repeatability, consistency, failure rates, up time, cost, operating issues and productivity rather than (for TRL 1-3) technology feasibility, process characteristics, the science involved, and laboratory prototypes. As a result, the technology take up by industry is often slowed down by a lack of investment in creating industrial laser processing facilities in an industrial or semi-industrial environment, engaging closely with university research groups. Such facilities, like those in Fraunhofer Laser Institutes in Germany, are badly needed in the UK.

To give an example I am familiar with, the Singapore government has set up a number of industrial research institutes, 80% funded by the government, with world class research facilities and typically 300 staff members for each institute. Their purpose is to develop industrial applications of new technologies. I have been a visiting Research Fellow for SIMTech (Singapore Institute of Manufacturing Technology) for the last two years and have experienced its operation and successes. I highly recommend we establish such research institutes in the UK in several key areas.

Some universities have started to address this problem. For example, with the help of regional development agency and industrial funding Sheffield University has set up an Aerospace Manufacturing Research Centre (AMRC) that has standard and advanced production machines operating in a semi-industrial environment. TWI and QinetiQ have been successful in conducting industrial research, but they do not usually function as a bridging agent for university technologies unless their industrial customers ask them to do so. I should also mention that the Rutherford and Daresbury laboratories have been active in advanced laser technology development.

TSB and EU grants help universities to work with industry in consortia and projects. These activities aid effective technology transfer but capital investment is still needed to enable the take up of the technology by the end users. However, unless end users consider the technology to be at TRL6 or 7 they

would not like to risk of investing in the required high power laser facilities. So the question remains: who will undertake and who will pay for TRL4 and 5 work involving high power lasers?

What steps do you take to make research relevant to industry, UK plc in particular?

We work closely with industry and many projects are industrially funded. With the introduction of full economical costing (FEC) at UK universities, direct funding by industries for projects over 1 year may become difficult. Typical cost for a postdoctoral researcher is £100k/year under FEC. A good way forward is for industries to participate in and lead TSB and even research council funded projects. CASE studentships and Engineering Doctorate are cost effective ways for industry to work with the universities.

What is your response to the claim that universities are too slow, unreliable and expensive when it comes to undertaking sub-contract for industry?

I do not totally agree with this, particularly on reliability. Contracts are needed and paper work is needed for the contracts. Once funding is in place, project quality is very much dependent on the group and the researcher. As universities do not usually have permanent research staff working solely on industrial research, recruitment of researchers for particular research projects is the usual practice. The quality of research will depend on the researchers recruited and the research group managers, If a student is involved, training time is required. Faster output can be delivered by postdoctoral fellows and experimental officers, but they cost more.

Isn¹t the need for university people to publish their work a major hurdle to effective collaboration with industry?

Not a major hurdle, but the requirements for high quality academic work for publication may not always be consistent with the requirement of industry. Many university research groups can satisfy both. For example, we have 3 engineering doctorate and 1 CASE projects, currently run and partially managed by industries. Industrial interests are met and publications are allowed in these projects.

However, for small projects (say, less than 6 months) where there will be no publications and no student training can be made, there is less incentive for universities to undertake the work unless there is a prospect of a long term research relationship and money is sufficient to employ a postdoctoral fellow. If the timing is right, student training can still be included from 3-6 months projects for MSc and undergraduate projects. Such projects do not require a publication to be made.

How do you deal with issues of industrial confidentiality?

We have many confidentially issues to deal with. This is usually not a serious problem. For all our industrial projects, confidentiality agreements will be signed by all the parties. All the research papers prepared for publications have to be cleared by the industrial partners first. This can sometimes slow down the speed of publications and many researchers find this difficult to cope with.

What impact in the Photonics Knowledge Transfer Network in the UK having on your work?

I have attended a number of PKTN and AILU organised workshops. They have provided a very good forum for interactions between academics and industry. One of the overseas collaboration with significant inward investment was generated through one such event.

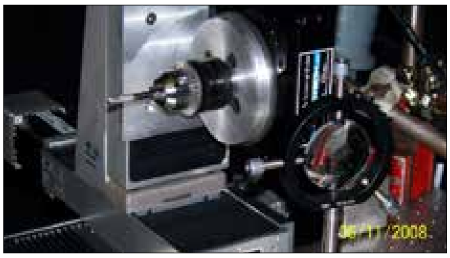
Can you give examples of processes or applications developed in your research group that have lead to a new products or process being implemented in industry?

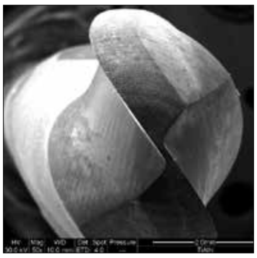
Certainly. Here are three examples.

Laser Fabricated Jewellery

The laser manufactured jewellery shown above is the result of an North West Development Agency (NWDA) industrial CASE studentship funded by EPSRC and Northwest Design Initiative. The work was carried out by artist Sarah O'Hana as part of her PhD project.

Laser removal of hard coatings for tool recycling





Hard tool coating removal by laser (above), and the tool after coating removal (right) showing no change to the tool sharpness and geometry.

This work is part of a DTI/EPSRC funding in collaboration with 5 industrial partners including Teer Coatings Ltd, Rainford Precision Ltd, Microsystems Ltd, Hanson Thorpe Precision Ltd, Rolls-Royce plc and Innovative Biotech Ltd.

Laser cleaning of aerospace components for electron beam welding

This demonstration shown here is of laser cleaning of an aerospace component for electron beam welding. It is the result of a PhD project carried out by Dr Mark Turner from Rolls-Royce at the University of Manchester. It is currently being installed at Rolls-Royce.

How do you determine your future research activity?

We currently have several strands of research activities on-going, involving over 20 PhD students and 8 postdoctoral researchers supported by a number of technical staff working in the area of laser cutting, welding, drilling, surface engineering, micro/nano fabrication and additive/rapid manufacture. The research has been funded by EPSRC, NWDA, TSB, EU, industry and overseas governments. We have almost all types of laser processing facilities including CO_2, Nd:YAG, Excimer, DPSS, diode, fibre, Ti-Sapphire lasers and analytical facilities including SEM and AFM within the LPRC laboratories. Most of these facilities are less than 3 years old.

Future research activities need to align with government funding strategies and priorities as well as industrial needs and within our facility capability. In addition, we have to focus on our strengths and adapt to the new needs and challenges. Many new research project ideas are generated by attending conferences and workshops. A requirement for the university research projects is that they have to be novel and be intellectually challenging so that publications can be generated and students can get degrees. Typical projects are 3-4 years, mainly looking at long term issues. These requirements are sometimes different from industrial projects, which may require the digestion and application of a tried and tested technology to a particular application and may involve little if any research.

University professors are often criticized for "empire building" and being unwilling to collaborate well with one another. What experiences do you have of such collaborations?

I have had very good experiences of academic collaborations. For example, the Universities of Manchester and Liverpool laser groups formed a Northwest Laser Engineering Consortium funded by the Northwest Development Agency. We have shared research work and facilities over the last 3 years and this will continue even after the funding finishes.

continued over ...

We are also currently collaborating with Heriot Watt University, University of Nottingham, University of Cambridge and Cranfield University on processing using next generation industrial lasers funded by the EPSRC. New laser facilities (1 kW single mode fibre laser and 400 W DPSS laser) at the University of Manchester has been offered to the above universities for research projects and collaborations. With the introduction of EPSRC Programme Grants recently, academic collaboration is almost an essential requirement to obtain large grants from the research councils. The UK government is promoting academic collaborations. UK industry could also do this by forming large academic and industrial consortia for challenging, high impact industrial projects, funded by the UK government and the industry.

Would you like to comment on the current shortage of laser engineers in Western Europe and the USA? What can be done to encourage more students to take up engineering degrees?

In recent years there has been a decline in the numbers engineering student applications at UK universities. Subjects relating to business and finance attract increasing numbers of student applications. In Germany, mechanical engineers are in great demand and they usually secure job offers with very high salaries before they graduate.

The lack of laser engineers in Western Europe and the USA is not surprising since few if any of their universities offer laser engineering undergraduate degrees. Professor Steen predicted the decline over 15 years ago and called for the establishment of Laser Engineering degrees in the UK universities but this has not yet happened.

The University of Manchester has recently established a Photon Science Institute aiming at high quality research and training of students in this area. University PhD graduates in laser processing are very experienced and capable in a particular area; nevertheless, they usually don't find it easy to find jobs in the UK. The University of Liverpool and University of Hull have MSc programmes training 1 year master degree students in laser engineering, but not all of their graduates succeed in finding good jobs in the UK laser industry. The UK industry can influence this: offering jobs with a good salary would be a start; collaborating with UK universities would be another way of attracting recruits.

In recent years your group, which previously dealt exclusively with macro laser processing, has moved more towards micro processing. How successful has this been and what are your plans for the future in this area?

The Northwest Science Council established the Northwest Laser Engineering Consortium, a collaboration between the Universities of Manchester and Liverpool. Through this we have successfully established infrastructure and research capability in laser micro/nano processing. This has been very successful with significant international impact generated within a short period of time. I have given 4-5 keynote and invited presentations at a number of international conferences and workshops on laser micro/nano fabrication over the last two years as a result of this new activity. Also, inward investment from outside the UK has been generated for research collaborations in this area in addition to the UK funded projects. The University of Manchester is mainly focused on laser nano fabrication technologies. We are keen to collaborate with UK industry to transfer the new technologies developed; technologies such as laser micro/nano surface texturing, which has applications in self-cleaning, improved aerodynamic, hydrodynamic and tribological properties of surfaces, and for improving cell adhesion on medical implants.

How do you see research funding opportunities in laser engineering?

Laser processing research is multi-disciplinary requiring the knowledge of engineering, materials science, physics, chemistry, mathematics, instrumentation and sometimes biomedical science. I see the opportunities for funding as good, but not without hard work to obtain the funding. Collaboration is essential and good ideas are important. Working with industry in the collaboration is very important.

WELCOME TO NEW CORPORATE MEMBERS

Eminox Ltd

Fianium

Hobart Lasers Ltd

PRIMES GmbH

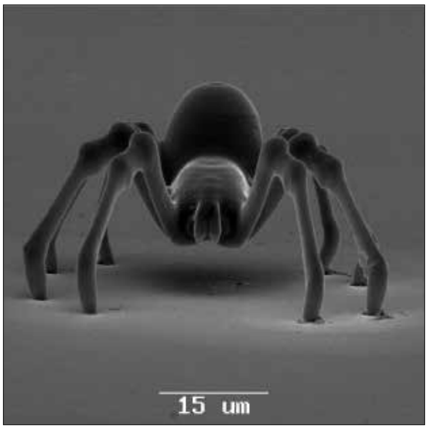
Steel & Alloy Processing Ltd

AILU Member signs

We have a new supply of laminated AILU signs (216 mm x 150 mm) available for members to display on their exhibition stands. 'Introducing AILU' leaflets are also available.

Help AILU reach out to the laser user community and thereby increase the value of membership through networking activities. To receive a Member sign please contact the AILU office.

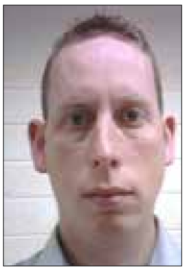
Most GORGEOUS PART



The scanning microscope image is a demonstration structure in SUB (an ultraviolet photoresist), produced at the Laser Zentrum Hannover using a femtosecond laser and 2-photon polymerisation. The micro-spider is 6 µm above the glass. It's body is supported by legs only 1.7 µm thick.

Further details of the technique and results can be found in the article on page 44 of this issue.

The take up of lasers in the semiconductor industry



David Gillen

Recent developments in high average power short pulse lasers have raised the awareness of their many positive processing characteristics in the context of industrial production of components with micron-scale features, such as semiconductor chips. But for an industrial application we need to look further than the processing characteristics of the laser and consider its economic attractions when compared to existing technologies; such as (in the case of semiconductor chips) Deep Reactive Ion Etching and the mechanical saw.

AILU members should be good ambassadors and keen to drive and expand laser technology in the micromachining market but we also have a responsibility to understand deficiencies as well as benefits. All of us who have an interest in this market know that laser micromachining has not been taken up as much as we thought it would have been and although the global semiconductor equipment market is $40B, we are but a tiny percentage of that. Having worked in the semiconductor industry for the last 10 years, developing both plasma and laser process technology, I would like to express my opinion on why the take up has not occurred.

Incumbent Technology

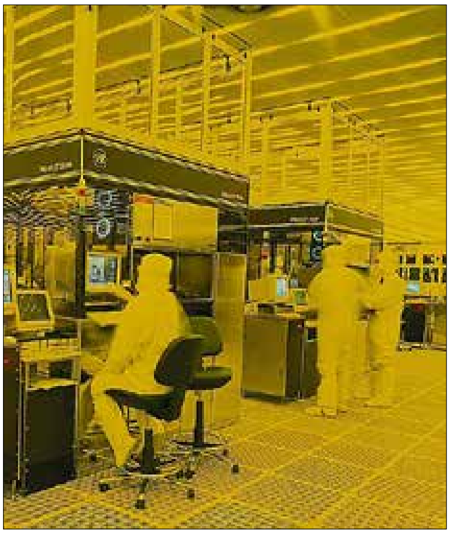
In general lasers are marketed as an alternative to an existing technology and as such they have an uphill battle to gain market share. If we take wafer dicing as an example, the existing mechanical saws are cheap, reliable, fast, easy to use, and unfortunately in terms of the key metric of die strength, superior to laser cut wafers. Even though a laser has a lower depth of sidewall damage, studies consistently show the mechanically sawed dies come out on top. Although two-step processes exist to increase the die strength after laser dicing by removing the recast layer, it is an extra cost and is probably just as applicable to saw cut wafers, thereby negating its competitive advantage.

It is interesting to note that Disco, a leading provider of mechanical saw equipment, has performed best in terms of laser dicing equipment, with reports of around 40 machines installed in the last year. The reason may not be down to their technology as much as to Disco's closer geographical proximity to the majority of their customers and the fact that they have developed their products accordingly. Although the West still develops most laser technology, it is increasingly exported to the Far East. This separation of end user and product R&D centre generally diminishes uptake of any product.

Product Variation

Each semiconductor manufacturer has a different device, made up of different metals and dielectrics and varying in stack depth and die size. Even along the dice lane, the difference in alignment marks, test element groups and street width make the development of a generic laser dicing solution a hard task. The above is also applicable to through-silicon vias. In this case the ability to drill through the bond pad without destroying or delaminating adjacent electronic components is vital.

Additionally, since the majority of laser processes are backend, they are susceptible to changes in front end design. This means that an alteration to stack material in the front end could lead to a redevelopment of the laser process at the backend. One of the much touted killer applications for lasers was low-K scribing; however this never materialised, in part due to difficulties with the Low-K process itself but also that by the time the solutions were found the market had moved on. Although Low-K is still used, it will be 3-5 years before it becomes mainstream and even then it may remain a small percentage of the total number of wafer starts per year.



Wafer fab manufacturing 30,000 wafers a month. (Courtesy of National Semiconductor)

Laser Variation

In my experience the optimum laser parameters depend very much on the application and the material. For silicon machining, high pulse energy at 355nm seems the best way to go, presumably due to the correlation between the inter atomic bond strength of silicon, which at 3.5eV matches the photon energy of a 355nm laser. Although 532nm may have more power, nothing beats a resonant process in terms of efficiency and damage limitation. Is a 10 W picosecond system better than a 10 W nanosecond system? Apart from throughput, my own experience is that the picosecond system dumps a lot of energy in a very short time, which may have implications for sidewall damage and die strength. For other materials such as dielectrics and polymers, I think that low pulse energy, high rep rate is the way to go.

Most wafer damage is caused by rapid expansion of the material in front of the leading edge of the laser pulse train. This is especially true when you move from an area with metal in the dice lane to an area with dielectric e.g. test element groups in a dice lane. A high rep rate system tends to give the best results in these circumstances as well as producing the smoothest side walls. In an interesting talk at a recent AILU medical device seminar, Martin Sharp from the LLEC, showed that picosecond systems tend to have too much pulse energy; especially with regard to polymer ablation. It is also becoming apparent that the majority of sapphire scribing applications in Asia are using 1W nanosecond DPSS lasers. These are interesting results that should be taken on board by laser source developers.

Continued over

Lasers in SC Industry (cont.)

Cost
Lasers in general are highly complex, with abilities such as pulse to pulse variation in energy and rep rate. I have never understood why such a level of over engineering is necessary in tools that will more than likely work within a very tight operational parameter range. The cost of this extra functionality is carried by the system integrator and must be passed on to the customer. This makes laser systems far too expensive for most applications. If you consider dicing, were the top end mechanical saws sell for $450k, if the comparable laser costs $150k before integration, margins are going to be very tight. Laser sources need to be cheaper. It is good to see low cost entrants such as the Laservall Violino series and the SPI nanosecond pulsed lasers. I am sure that these lasers will find it easier to source applications within the market place.

A major concern going forward is who drives the development of laser sources? Why do I have to buy a laser source that can machine all dielctrics, semiconductors and plastics, when my customer is only interested in 200µm thick PTFE?

Many applications in both the medical and semiconductor sector cross my desk, and often the laser is the most efficient process. However, when you source the laser you find that it is not a cost efficient solution. More often than not it is a picosecond laser, with a €200k price tag, which puts the customer off. Newer companies, such as Fianium, seem to be taking this on board and are driving picosecond laser costs down; however there is still a way to go.

As a community with a common goal we need to work closer together to tie down laser specifications and hopefully lower laser unit costs. We need to look at new applications, were lasers are enabling and not up against incumbent technologies. However this may take a change of tack by the laser source developers. The existing approach, where the lasers are developed for existing markets such as wafer dicing, wafer scribing and silicon via production, just isn't working.

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Bad experiences of laser cutting machines in schools and colleges

Martin Sharp

I recently visited a nearby City Learning Centre in northwest England; basically a small Design and Technology unit attached to a school and with a brief to offer a service to the region's schools. They have the misfortune to own a mid-size laser cutting machine that had been out of order for a couple of months. The tutors had been struggling to keep this machine running, and eventually had to exchange the laser source. We spent several hours trying to realign the system and in the end I was unable to overcome what appeared to be a design flaw. The horror story of the installation (by an agent working for the supplier in question) is staggering – the agent had used a cheap oil-filled compressor to provide compressed air to the assist gas line, ultimately damaging the optics, clogging the pipe and causing a significant fire; he had also sprayed WD40 onto the axis and in doing so had seriously contaminated one of the mirrors without any understanding of his action. On top of all this, the tutors told me of four incidents in three local schools involving laser cutting machines where the processing material had caught fire. I don't think these were significant fires, but the fact that they have taken place implies a lack of understanding and control of the risks involved. They also had concerns about fume extraction and "smells". Typically these schools are cutting and engraving acrylics, MDF, cardboard, vinyl etc.

Following the open forum discussion at the AILU AGM in April concerning the shortage of laser operators and laser engineers, what worries me about the performance of these machines in schools is its impact on the children who are exposed to laser technology at school age. My experience is that they get very excited and when all goes well come away with a positive view of laser technology. But what when they find that the laser is out of order, or it breaks down in the middle of a project; or, even worse, causes a fire that damages their project and prevents fellow students from using the equipment?

There are tens of companies offering laser cutting systems to the secondary education sector. Many are importers of cheap machines from parts of the world where safety is not a priority. The quality of these machines must be in doubt and I am sure a number of the importers have no real knowledge of how they work. The education sector is a soft target - they have to buy on limited budgets and will rarely fight over problems in supply.

The teachers and tutors love this laser technology and it fits the current curriculum for design and technology well. But they are lacking support in their operation and related issues. Should AILU be doing something about this?

Responses ...

School D&T departments are soft targets for laser sales but are also a first class recruiting zone for enthusiastic laser users of the future. The education of engineers fluent in the application of optical energy is of paramount importance and the equipment supplied to school D&T departments must be made to work correctly, safely and to be readily serviceable. To have agents coming in and spraying oil over the optics is certainly not good for the subject or the laser industry.

I think AILU could help by supplying schools with lists of accredited suppliers and to be prepared to shame suppliers that perform as described by Martin. AILU might also be prepared to give lists of potential speakers who could give a lesson or two on lasers or tell laser related stories. A further activity for AILU might be to organise the production of "Masterclass" DVDs on various laser processes for use in the class room. A short illustrative clip that the teacher can insert into a PowerPoint presentation is all that I believe is needed.

Bill Steen

continued opposite ...

Letters to the editor

The Laser User Spring 2008: Issue 50
Upon reading the Observations by Andy May, which referred to the paper, "The Clearweld® Process for Plastics Manufacture," I feel obliged to explain and emphasize the scope of Clearweld®. The objective of the paper was to explain the technology platform offered by Clearweld, for the benefit of your readers. The product range included in the article covered:

1. Custom-compounded resins to facilitate the welding process in the range 808 to 1100 nm.
2. Clearweld coatings, designed for use with lasers in a wavelength in the range 940 to 1100 nm.
3. Clearweld semi-finished products, which are injection moulded or extruded to meet specific requirements; the example given was Surebond® tubes, a joint development with Natvar Corporation.

The breadth of the product range explained in the paper, "The Clearweld® Process for Plastics Manufacture," was not acknowledged in the Observations.

Clearweld was developed jointly by Gentex Corporation and TWI with Gentex retaining the exclusive rights to commercialize the process worldwide. In this context, Clearweld works with a number of companies worldwide, which provide materials, equipment, resources and support to implement the plastic laser welding process. The Clearweld strategy is one of collaboration; expansion of our global network is pro-actively pursued through Partnerships, co-development programmes and alliances, covering:

1. Plastics welding companies,
2. Laser companies,
3. Dispensing companies,
4. Materials companies,
5. Masterbatchers,
6. Integrators, and
7. Contract manufacturers.

For example, to increase the uptake of lasers for laser welding of plastics, in June 2004, Gentex Corporation granted BASF AG a worldwide license to use and sell Lumogen® additives to produce plastic resins for moulding laser-weldable components. Resins containing the BASF additives provide users access to Gentex's patented Clearweld® process for laser welding plastics.

The mission of Clearweld is to promote the interests of laser users and non-laser users in the industrial application of lasers to plastics welding, thus underpinning the expansion of the laser market.

As Global Business Manager of Clearweld®, I would welcome any suggestions that the readers of this valuable magazine may have on how to serve your needs better, our website, http://www.clearweld.com/, provides an educational tool and more information on all aspects of our services.

Yours faithfully,

Gareth C McGrath
Clearweld Global Business Manager

Lasers in Schools

Martin's first experience with lasers in schools is a terrible one that gives an awful impression of what can happen! If this is the norm throughout the UK, it's a terrible situation that must be put right!

Thankfully, our company's experience of installing such equipment in schools in Wales is quite different in almost all aspects. The one similarity is the unforeseen breakdown, which is a fact of life.

But the other problems Martin highlights were, as Martin points out, due to the installation and training being cut short or insufficient, or perhaps to bad design.

It seems the training provided did not deal adequately with the hazards and proper use of equipment. Cost pressures can push for a quick install but experience has shown us that a full 2 days is best, giving teachers the opportunity to learn and question before being left in charge of the laser and their class.

Although I can only speak for Lasers Are Us, our experience with schools has been very positive. I must thank the teachers we have been involved with because it is clear to me that their enthusiasm for the technology spreads to the pupils and together they produce excellent work, courtesy of the laser! On the whole the benefits are sky high within the current system.

AILU might contribute in helping schools specify a machine particularly regarding compliance, since there are low priced machines being sold in the UK that either are not CE marked or clearly do not meet the requirements of the relevant standards. AILU could also help in guiding teachers in what to expect from the training course provided by the equipment supplier.

Simon Lau Lasers Are Us.

I have concerns with the increasing levels of product of doubtful quality, unsafe and un-fit for purpose, that is finding its way into education from overseas.

The current educational demands and limitations on school capital budgets in particular has opened up the means for some people to profit without proper commitment to guarantee or support their wares after they have passed into the market place. I have come across many instances at UK educational sites where poor purchasing decisions have lead to lasers ending up lying unused due either to the costs of repair or to the difficulty getting them repaired. In some cases the spares are not held locally; in other cases the only option was for the machine to be sent back to its place of origin, which could be half way around the world.

Barry Abson CADCAM Technology

A couple of years ago I was asked by an art and design college in London to arbitrate between the college and the supplier of a small laser cutting machine. I had never seen such a machine before and had grave reservations about aspects of the installation. Of particular worry was the lack of information provided by the supplier as to what materials could safely be cut and the fact that little attention had been paid to the removal and/or treatment of the fume, even though the supplier was taking 'systems' responsibility. I was told that on more than one occasion when cutting Perspex sheet, students being lectured in the next room had walked out due to the smell.

Paul Hilton TWI

We should perhaps write a guideline for teachers who intend to buy a laser cutting machine and advertise it via the AILU website. We could guide teachers towards suppliers that adopt good practice.

John Powell Laser Expertise

PRESIDENT'S MESSAGE

It is my honour to be AILU President for 2008/2009. The out-going President Clive Ireland put in a tremendous effort last year and it will be a hard act to follow. I know the rest of the steering committee is very appreciative of the work Clive did and I would like to thank him on their behalf.

One of the major initiatives that Clive introduced was the concept of sub-groups within the steering committee. These sub-groups have specific topics to consider and take forward. Examples include AILU events, website and magazine, membership etc. The prime objective of these groups is twofold; improving the efficiency of the steering committee and reducing the secretary's workload. It is one of my goals to try to ensure the sub groups achieve these objectives.

Significant progress was also made by Clive in improving AILU's financial planning. This progress needs to continue as it is necessary for AILU to be on a sound financial footing with a positive cash flow each year. We will continue to strive to achieve this and any suggestions or input from the membership would be very welcome. Could I ask all members to spread the word about AILU and the benefits that it provides?

I recently attended an EU Innovation Forum which considered the future demands on laser processing in manufacturing and repairing aircraft, including aeroengines. Changes are occurring in the aircraft business including the use of new materials, expansion in breadth and depth of the supply chain and a move towards a more service based industry. These changes have affected the business drivers with more emphasis on reducing costs, especially whole life cycle costs. The implications for future laser processing systems are quite large and can be summarized as:

- Processes are needed that are applicable to new materials and combinations of materials
- Processes need to be developed that are:
  - ==> Robust
  - ==> Portable
  - ==> Devoid of black art
- Processes need to produce parts with high quality and reliability in order to minimise whole life-cycle costs.

Whilst these are challenging objectives I believe that there will be many new opportunities for laser processing in the future in the aerospace sector.

If anyone would like more information about this feel free to contact me through the AILU website forum or by email (s.williams@cranfield.ac.uk).

Stewart Williams

AILU advertising

AILU has engaged Genesis Sales & Marketing (Adlington, Lancashire) to provide a range of activities in relation to the sale of advertising space within this magazine, on the AILU main web site, the Design for Laser Manufacture site and in the forthcoming monthly e-newsletter.

Commenting after his first few sessions of contacting potential advertisers, Tom Pettit, MD of Genesis, expressed delight at the warm reception he had received from AILU members. "Members were very positive about AILU and most were interested both in the value for money that AILU advertising represents and in the range of frequency/media/reader that the four advertising media offer."

Contact: Tom Pettit

E: genesis.marketing@btinternet.com

Advertising with AILU

The DLM site only accepts 'google-style' adverts; the main site and newsletter accept graphics as well.

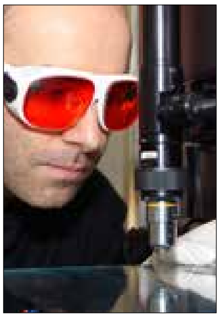
The AILU web sites are highly rated by search engines. The e-newsletter will be quarterly and go to several thousand laser users in the UK and world-wide.

(top-l)) mock-up of the e-news letter; (top-r) main web site; (bottom) DLM site home page

RULARDO phase 1

Within the Photonics Knowledge Transfer Network (PKTN) AILU is a lead organisation with responsibilities for 'Power Photonics' activities i.e. materials processing applications. In addition to funding for general activities, AILU has been successful in securing additional funding for the first phase of a project, RULARDO (Review of the LAser materials processing market to identify future Research and Development Opportunities), to provide the KTN with a better understanding of the competitive position of laser based materials processing in the UK and, by so doing, identify the gaps and weaknesses that might best be addressed by appropriately targeted R&D activity.

The RULARDO working group comprises Paul Hilton (leader), Clive Ireland, Malcolm Gower, Bill Steen and John Powell.



Courtesy Laser Machining

The Phase 1 work will cumulate in the production of an interim report on the current top-level UK industrial and academic R&D, identifying products and systems offered, main markets/customer-bases addressed, R&D and technology interests and training and education offered. This short and intensive audit is being carried out over a 3 month duration by Bill Steen and John Powell.

The main content of the Phase 1 report will be a capability map of the principal UK academic and industrial activity, which will show up current strengths and weaknesses and, subject to approval of Phase 2 funding, it will form the basis for an invitation-only event a few weeks later (mid September/October) to engage senior members of the industrial committee in a balanced discussion of research opportunities across the whole spectrum of laser materials processing activities.

The intention is to highlight gaps in UK capability where near-term (1-5 year) targeted R&D work might best strengthen overall UK performance in manufacturing.

Job shop corner

Dave Connaway
Chair

The Job Shop Group committee meeting on Monday May 12th was the hand-over point between Neil Main and myself as Chair of the Group. Being the only member of the committee in deepest Sussex and always having to take my passport to committee meetings held in the far North of this pleasant land, I think we put on a truly magnificent show of weather and hospitality on the preceding Sunday evening in Brighton and on Monday at the meeting. After lunch on Monday we ended with a guided tour of our production facility at Cirrus Laser, and I think everyone was appreciative of why we live and work in such a beautiful county as Sussex.

Our out-going Chair, Neil Main, will be a hard act to follow and I would like to thank him for all the hard work and leadership he has given the group over the past 2 years. Like Neil, I have been in the job shop business for some time. In fact it was 21 years this August 1st that we started Nimbus Laser Services Ltd which in 1999 became Cirrus Laser Ltd after a management buy-out and elevation to a higher plane. We started with a state of the art 1.2kW Electrox CO_2 machine, but machines now have more power, quicker drives, better cutting nozzles and much quicker cycle times; and instead of a “Made in Britain” sticker they are usually imported from mainland Europe or the Far East. But progress must continue and in an era of reduced margins, job shops must use the latest technology to stay alive.

So what are my plans for the JSG during my 2 years as Chair? Firstly I would like to increase the membership of the JSG part of AILU and the committee under Neil’s guidance have been seeking the help of machine manufacturers to help with pointing new user’s of lasers in our direction. The new AILU web site with a JSG forum, our annual Job Shop Business meeting, AILU workshops at regular intervals and the JSG surveys for laser gas, electricity prices etc. are good enough reasons to attract more members. With these benefits on hand it should be a breeze getting the membership numbers up!

Secondly I would like to continue the work already started by the JSG committee, including participation in the Design for Laser Manufacture (DLM) initiative and producing a Laser Operator training manual. These are but two of the many items that are under scrutiny by the committee with much appreciated help from Mike Green who steps-in as not only the AILU secretary but also our JSG meeting secretary with the unenviable task of keeping notes of various actions at our bi-annual meetings.

Finally the AILU workshops are a great method of understanding new laser processes and need to be taken to a wider audience in the JSG membership. Job Shops need to find new markets or become stagnated; and a Job Shop without new ideas and growth will eventually decline, so it is important that we get as many members of the JSG as possible to be looking forward.

The 2008 annual Job Shop Business Meeting will take place on Wednesday November 12th at the premises of Trumpf UK Ltd. Many thanks to Hartmut Pannen, the Trumpf UK MD for allowing the JSG to use their facilities and the committee will be working towards making the meeting the best yet!

Dave Connaway Job Shop Chair

2007 job shop survey results

Every year the job shop group undertakes two surveys for its members. It is FREE to take part, participants details remain anonymous and confidential throughout, and only they will receive the results, with a code letter that enable them to identify their company data and compare costs with those of the other participants.

Debt Protection Survey
AILU's first survey into the approach laser job shops are taking to protect against bad debts attracted the participation of 35 job shop members. We are grateful to Neil Main (Micrometric) for his assistance in analysing the responses.

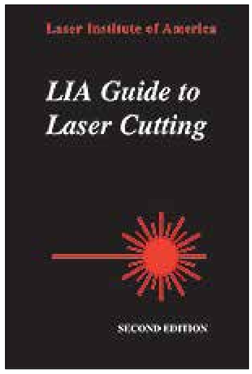
Interestingly, of the 35 job shops who responded, almost half do not have any form of debt protection. Of those that do, most pay for information services and the survey results reveal a wide variation in cost and options available. In addition to seeking to know the risk of a company defaulting most of those who use such a service also take out bad debt insurance, the results revealing a wide range in strategies for “First Loss” (i.e. that is the amount that is not recoverable) and insured turnover. The final option, bad debt recovery was only practised by four of 35 participants companies and there are few details.

Gas cost survey
Gas companies appear to make it as hard as possible to compare gas bills and we are indebted to John Powell for devoting considerable time to disentangling the bills (delivered in anonymous format) and preparing the report.

There was a wide spread of results, some of which will, of course, be related to the total monthly company spend. John concludes that gas companies are still charging far too much for laser-quality nitrogen bottles and criticises gas suppliers for trying to get laser users to buy very high quality gas at high cost when only high quality is need.

Amazingly, given the proved value of the report for negotiating price reductions only fourteen job shops participated. Presumably the remainder either aren't interested/ too busy to save money or think they already get the best deal.

LIA Guide to laser cutting



The LIA guide to Laser Cutting - 2nd edition’, expanded from the 1st edition, can be ordered from the LIA web site at http://www.laserinstitute.org/ for US $39 + P&P (LIA member discount applies)

Authored by John Powell, the guide offers in-depth useful information for the small shop owner and large manufacturer. It addresses cutting of steel, glass, ceramics, wood, polymers and other non-metals

We are currently negotiating a discount for carrying copies at the AILU office. Please contact the office for latest details.

Fine laser cutting

Paul Harrison

Fine laser cutting is an area which in the past has tended to fall through the gap between flat-bed, large scale laser cutting on one side and laser micromachining on the other. Such topics are explained in detail elsewhere. Fine laser cutting at the sub-mm level has developed into a topic in its own right and deserves separate consideration.

Fine cutting can be described as cutting a relatively thin and sometimes flexible work-piece to produce small features with high accuracy and repeatability. The figures on this page show a selection of parts produced by fine laser cutting. Such parts can be manufactured in a wide range of materials including many that are either so hard, tough, soft or brittle that they are difficult to process using conventional (contact cutting) methods. The non-contact nature of laser processing and small size of a tightly focused laser beam are key to the fine cutting capability of the process. Several markets have produced a demand for fine laser cutting, driving the development of many different applications.

Fine laser cutting has several features that set it apart from other types of laser cutting. These are addressed below.

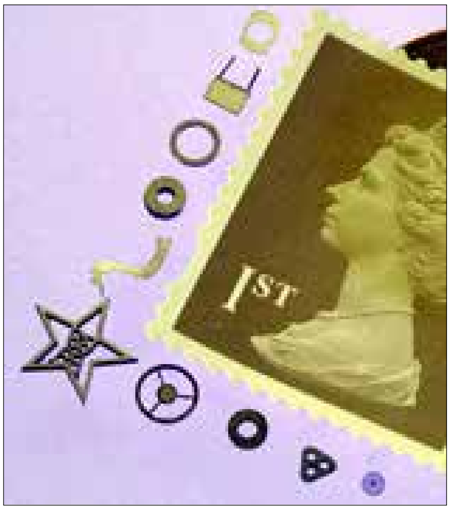
Choice of laser
For flat-bed macro-scale laser cutting, the high power CO_2 laser is the industry work horse, but for fine cutting the choice of laser is not so clear. The primary reason for this is the demand for a wide range of materials that are processed, including metals, plastics, ceramics and composite parts. The CO_2 laser remains an option (but as a sealed unit, with a pulsed or CW output), but so too are many types of Nd:YAG laser (flashlamp or diode pumped, at fundamental, second, third or fourth harmonic wavelengths), fibre lasers and excimer lasers.

Courtesy Micrometric

Within each of these laser types there are many variants, the choice of which rests primarily on a consideration of output characteristics, the main ones of which are listed below.

Laser Wavelength
In order for a material to be laser processed, it must be able to absorb at least some of the laser beam. Some materials are highly absorbing at all available wavelengths but other materials (and even different grades of a the same material) have different spectral absorption characteristics i.e. specific wavelengths at which they strongly absorb and other wavelengths at which they are transparent. For such materials there is no single laser wavelength that can process them all; conversely, for a specific laser (and laser wavelength) the material characteristics of the part being processed will determine the beam absorption and how well the laser will process the part, all other things being equal. Generally, Nd:YAG lasers with a fundamental output wavelength of 1064 nm are more suitable for processing thin metals, whilst CO_2 lasers (with an output wavelength of 10.6 μm) are more suited for organic materials such as wood, rubber and plastics. A point to note, however, is that the laser process generally creates significant (but localised) heating of the part, and temperature rises result in increased optical absorption. Consequently, power from the laser will initially be coupled into a material with a low nominal absorption coefficient at room temperature causing a temperature rise which will increase absorption and perpetuate the process. The cutting of aluminium is one such example.

Focal spot size
Generally any laser beam that can be focused to a small spot is a candidate for fine processing work. Other things being equal, the size of the focal spot is proportional to the output wave-



Courtesy Micrometric

length of the laser. This means that, in broad terms, the beam from a Nd:YAG laser (wavelength 1.06 μm) can focus to spot sizes one tenth that of a CO_2 laser beam (wavelength 10.6 μm), provided that the quality of the laser beams (defined by M^2 or BPP, the beam parameter product) are the same.

It follows that lasers operating at shorter wavelengths are capable of generating smaller focal spots and potentially of doing finer work. This smaller spot size, if not required for a particular job, can be traded for a longer depth of focus, thereby allowing a greater positional tolerance – something very useful in practical terms.

Pulse width
Many lasers produce a pulsed output rather than constant wave (CW). Such lasers offer high peak powers for processing materials but low average power, thereby minimising the overall thermal load on a workpiece. Pulsed lasers currently offer a wide range of pulse durations (pulse widths) from milliseconds through to femtoseconds. As a general guide, for a given laser output power, the cost of the laser will increase with decreasing pulse duration. The thermal penetration of the laser beam into the work-piece (the depth of material that is heated during the laser pulse) is proportional to the square root of the pulse duration, therefore reducing the pulsewidth can give a smaller heat affected zone (HAZ) and a potentially higher quality cut.

Cost of ownership
What is generally important is not the cost of laser ownership *per se* but the cost in comparison to processing quality and speed i.e. to profit. Such comparisons come up, for example, in the

trade off between cut quality, which is generally better with the shorter pulse (but higher cost) lasers, and average power, which generally equates to processing speed and higher cost lasers.

Process Mechanism

Whilst the mechanism for typical flat-bed laser cutting of metals is reactive fusion cutting (i.e. melt, burn and blow), a wider range of process mechanisms are applicable to fine laser cutting, in particular vaporisation cutting, fusion cutting and cold cutting. Fine cutting has also been achieved by delivering the laser beam through a narrow water jet, resulting in high quality cuts with very low recast levels. See inset box for a list of laser cutting mechanisms.

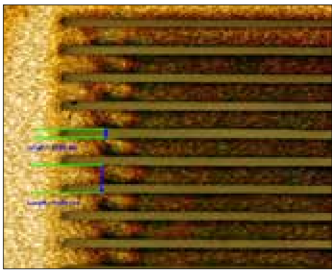
Cutting System Configuration

Handling sheet materials for a standard flat bed cutting system is relatively straightforward because all types are

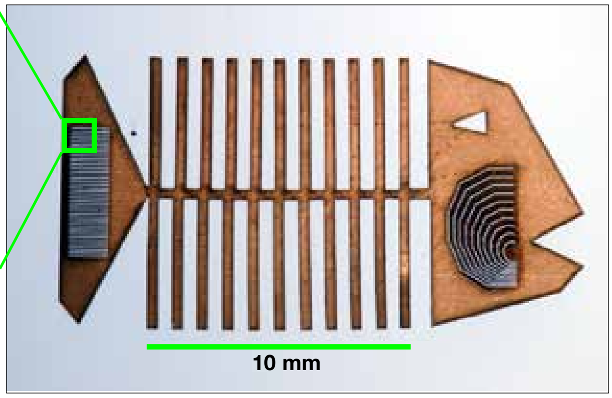
Laser cutting processes

Laser cutting processes can involve one or more of 7 distinct cutting mechanisms as described below [1]

- Vaporisation Cutting – material removal by vaporisation.
- Fusion Cutting "Melt and blow" – the laser beam creates a melt pool and a co-axial gas jet blows the liquid out of the bottom of the cut.
- Reactive Fusion Cutting "Melt, burn and blow" – similar to fusion cutting except that the co-axial gas jet reacts exothermically with the molten material, adding another heat source to the process.
- Thermal stress cracking – the process of creating a controlled thermal fracture steered by the laser through the material. Only applies to very brittle materials, typically glass.
- Scribing – the process of making a groove or line of holes in the material sufficient to weaken it so that it can be mechanically broken.
- Cold Cutting – this process uses ultra-violet wavelength light to break molecular bonds within organic materials. There is no heat affected zone.
- Laser assisted oxygen cutting – this process uses the laser as a heat source to ignite the metal in an oxygen stream, and is used for cutting thick section steel.



Fine cutting of flexible printed circuit board. The slots above are 38 µm wide on a 125 mm pitch.



Courtesy Powerlase

in sheet format and usually many parts will fit onto one sheet. By contrast, part handling for a fine laser cutting system can be more complex, mainly because there is a much wider variety of workpiece shapes and configurations to be catered for, including tube materials and preformed blanks, together with issues of small delicate part handling. In many cases the time spent loading and unloading parts can be much greater than the laser processing time!

For all the above reasons fine cutting jobs are generally dealt with on a more individual basis than are jobs for macro cutting and this is reflected in the requirements for specific machine configurations, usually including dedicated part handling and fixturing. To increase throughput and higher yield, machines may also feature automatic loading systems. Short batch runs are generally less economic due to the large set-up time component, but there are some dedicated standard machines available for certain fine cutting jobs - such as thin tube cutting for stents.

Because of the trade off between focused spot size and depth of field, jobs that require the smallest features require very stable and accurate focus control. Such machines may require temperature control and vibration isolation.

Application areas

The markets for fine laser cutting are diverse and include two sectors that have seen many applications: micro-electronics and medical components & instrumentation.

Typical applications in the medical component & instrumentation sector are stent cutting and needle tip profiling. This type of processing can also be used to produce filters and scalpels. Typical micro-electronics applications for fine cutting include wafer dicing, lead-frame cutting, stencil processing (for depositing solder paste), cutting composite copper sheet for flexible PCBs (see figure above) and cutting silicon and polyimide. Other emerging markets include the jewellery sector where there are many applications for intricate cutting of many metals such as silver, gold, copper, titanium and stainless steel.

In summary, the fine laser cutting sector is among the most diverse and rapidly developing of the laser materials processing world. This type of cutting is used to process many materials, to produce components for many sectors and markets, and is expected to grow in terms of new applications and new markets for many years to come.

References

[1] Steen W.M., (2003) Laser Material Processing, Springer-Verlag, Chapter 3.

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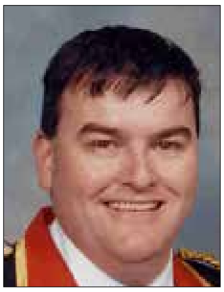

Paul Harrison gained a B.Eng from Brunel University in 1992. Since 2001 he has worked for Powerlase Ltd, as Applications Research Manager responsible for running the Applications Group. He is a Chartered Engineer and is studying for an Engineering Doctorate at Heriot Watt University.

See Observations p49

Laser cutting: a technology with some surprises in store

Bill O'Neill

I would imagine that the typical reader of AILU magazine is familiar with most laser based manufacturing technologies, particularly heavy weight processes such as laser cutting. Most research in this area was carried out in the 1970's and 80's and equipment manufactures' have developed extremely robust systems that are capable of operating with minimal operator intervention. The CO_2 laser have been used almost exclusively in this application and has benefited from increased beam quality (slab lasers), stable operation, and high levels of automation. One could argue that the process itself is mature, at the top end of its innovation cycle, and as such exhibits incremental advances in its technical specification rather than quantum leaps in performance. I think I would have agreed with this had I not attended the Laser Technologies Forum in Stuttgart this year, 4th -5th March 2008. The conference was very well attended and was the first to be held at the impressive Stuttgart Expo. The conference was also accompanied by an exhibition of the latest and greatest outputs from industrial laser vendors.

One or Ten?

The arrival of the high power Yb fibre laser has stimulated increased research efforts in laser cutting technology and process applications, with researchers keen to identify the abilities of these new sources in the area of laser cutting.

My research team has been engaged, like many others, in examining the capabilities and limitations of Yb fibre and Disc laser technology when applied to laser cutting. The last few years has seen a good number of research outputs from industrial and research base. The early results were suggesting that one micron sources were in fact far better than the incumbent technology at cutting thin sections with record speeds being attained, particularly on thin sections (< 3mm). As the technology tests are increasing, so the process window for one micron sources is beginning to settle towards a general consensus.

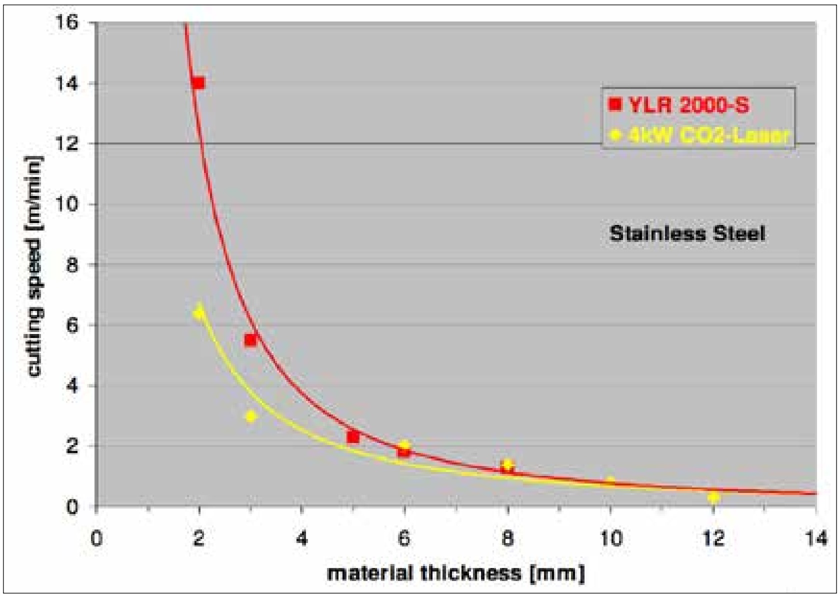

Figure 1 Comparison on Fibre laser versus CO_2 laser cutting of stainless steel. [1]

Here we take a look at some of the highlights and conclusions from the various speakers engaged in laser cutting at one micron wavelength.

Michale Grupp from IPG presented a comprehensive review of where high power Yb lasers were being applied in laser cutting. The data presented in figure 1 shows the performance comparison of a 2kW Yb laser with that of a 4kW CO_2 laser when cutting stainless steel. The results are impressive, with the speed advantages being gained at the low section limits, with laser output efficiencies giving the process an advantage at the higher section limit.

Research carried out at Cambridge, using Disc and Fibre laser technology has produced similar gains for 5kW operating levels, as shown in figure 2. The 5kW fibre data is taken from the work of Dirk Petring at Aachen. The trend lines show that the performance advantage for the one micron sources is largely restricted to the thinner sections. The advantages fall as section thickness increases. These results also show that the performance of the Yb and Disc lasers are comparable. The setup-up for the one micron sources require long focal lengths ~ 250mm in this case, and the use of multi-element lenses to reduce aberrations and improve focusability. A comprehensive review of conventional Yb fibre laser cutting was also presented by Beyer et al [3]; some results of this work are shown in figure 3 for Aluminium and stainless steel.

Beyer also presented an analysis of the quality comparisons between cuts obtained with Yb fibre lasers and conventional CO_2 lasers. These results are shown in Figure 4. It is quite clear in this case that CO_2 lasers offer better

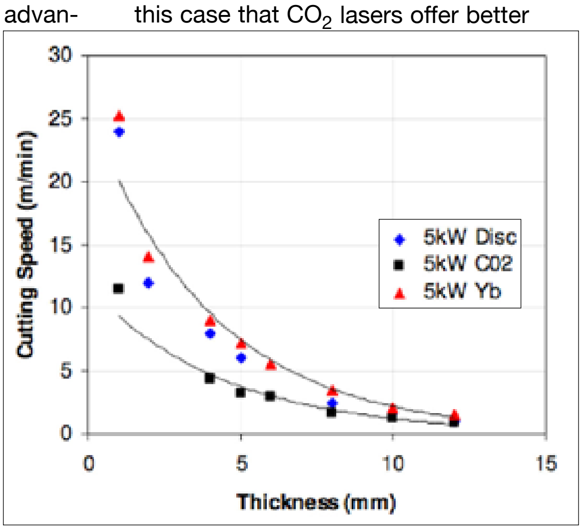

Figure 2 Laser cutting comparisons for stainless steel with fibre, disk and CO_2 sources. [2]. (5 kW fibre laser data courtesy of D Petring (Fraunhofer ILT, Aachen))

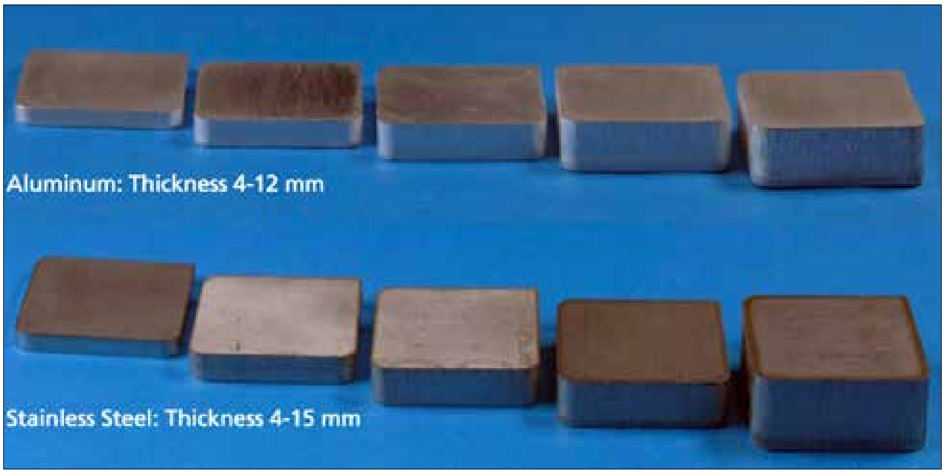

Figure 3 Yb fibre laser cutting results on Aluminium and Stainless steel in the range 4-15mm thickness [3]

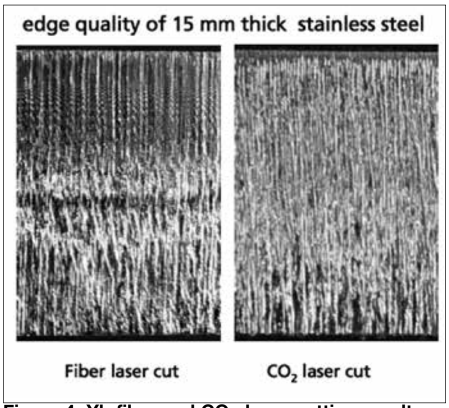

Figure 4 Yb fibre and CO_2 laser cutting results on Stainless steel: a quality comparison [3].

cut quality than what is obtained with one micron sources. Beyer cited a numberof differences that could account for the variation. Particular emphasis was placed on the differences in absorption between the two wavelengths, with the beam at one micron wavelength suffering greater absorption higher up the cut than the CO_2 laser beam which therefore enjoys better waveguiding and thereby better spreads the absorbed laser power down the cut.

The discussion of this topic was enhanced by the views of the Trumpf, the world leading producer of advanced cutting systems. Gerdard Hammann, provided a most illuminating talk on the views within Trumpf [4]. In his talk, he offered some results of their assessment of the attributes of one micron and 10 micron cutting. To cut an interesting story short, he suggested that the quality levels achieved with one micron sources were too low compared to those obtained with a CO_2 laser. He suggested that when cutting at 1μm wavelength the intrinsic advantages of melting capacity were offset by the fundamental challenge of melt ejection. When cutting at 10μm wavelength, he argued in favour of the flexible cutting applications and an opportunity to further increase melting capacity and melt ejection. I agree with this view, in that the melt ejection process can have it's efficiency increased by better nozzle design and some lateral thinking. My team at Cambridge are busy analysing detailed melt ejection models in order to design enhanced melt ejection strategies. Of course, these strategies will apply equally well to one micron sources, and so the argument of one or 10 micron cutting performance comparisons will continue to rage.

Some Novel Twists

I always enjoy it when a researcher gets up on stage and delivers a piercing blow to the operational conventions. This was the case in a number of talks. Beyer delivered a brilliant perspective on remote cutting, with cutting rates so fast that if you blinked you would miss the show [3]. For those attending the latest conferences, you will have seen the remote cutting videos showing 100 holes cut in 50, 100 and 200 micron thick steel in 1.17, 1.92 and 2.55 seconds respectively. A very impressive achievement that will see other researchers like me run down to the lab and repeat if not improve the performance levels of nozzle-less remote cutting. Watch this space and don't blink when the videos are launched!

We know that if we can improve laser coupling into the workpiece we can generally cut faster with better quality. Our current control of circular polarisation is one example where we compromise on absorption to get even cutting in all directions. We will suffer this compromise no longer if the work from Graf [5] and Hammann [4] is to be rolled out across the industrial laser base. Figure 5 shows the various polarisation modes that can now be implemented on high power laser.

Graf et al [5] presented the results of work that enabled a conventional FAF CO_2 laser to be radially polarised and therefore enhance laser beam coupling. Hammann et al [4] employed this concept in cutting trials using a TrueFlow 2.4 CO_2 laser, the results of which are shown overleaf in figure 6. It is clear that this new polarisation state has some significant benefits in both speed and quality.

Summary

To bring this brief excursion into new cutting developments to a close I would say that laser cutting research will deliver some new insights into the cutting mechanism that will allow one micron sources to become popular on the factory floor. Advances in the under-

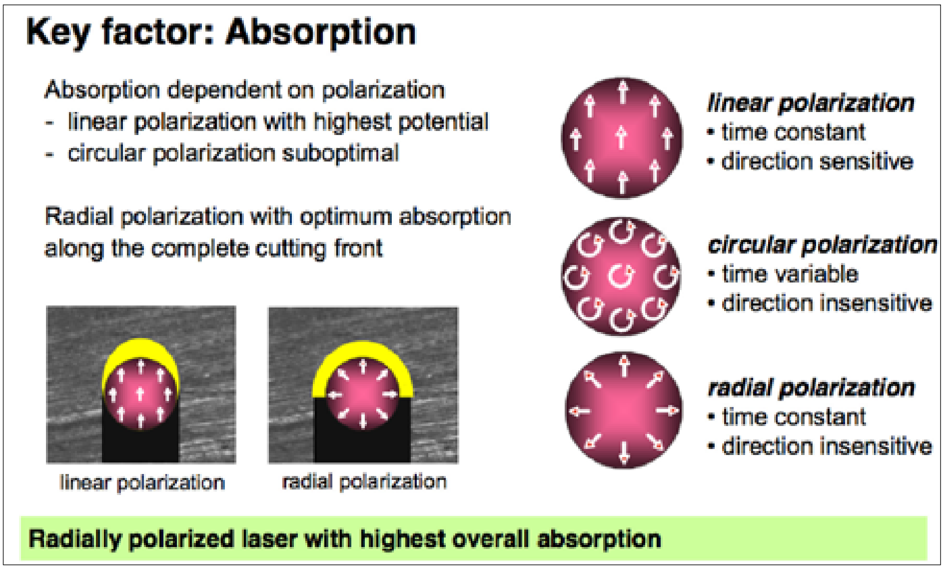

Figure 5 Various polarisation states that can be used for laser materials processing [4].

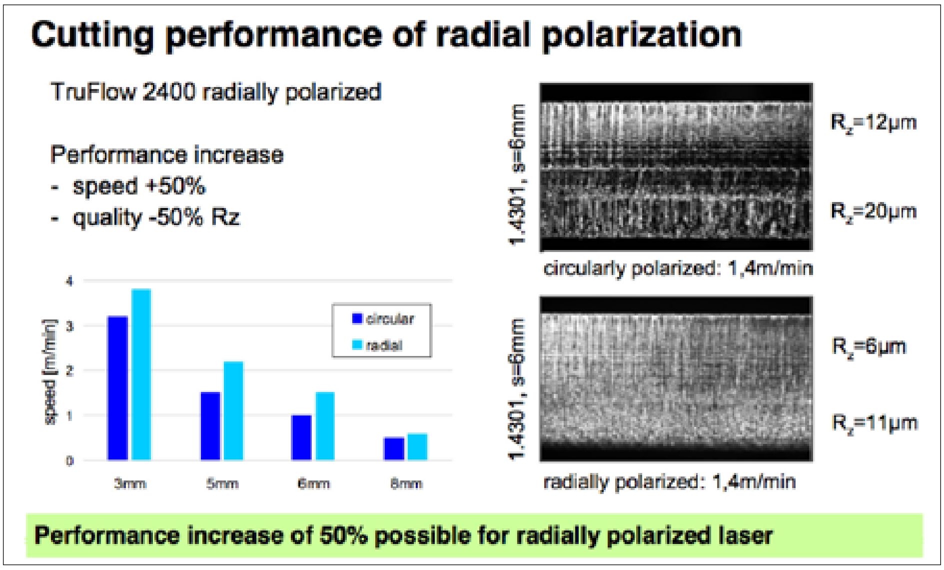

Figure 6 Cutting performance using radial and circular polarisation on steel using a CO_2 laser [4].

standing of the melt ejection process, coupled with better optical configurations, will deliver better quality cuts at one micron and 10 micron wavelength. Remote cutting is set to deliver greater levels of performance on thicker sections, and could offer new technology configurations for workshops AND jobshops. Manipulation of the polarisation state to radial, will enhance current cutting systems performance and may well find applications in welding and drilling. Those engaged in making money through cutting will certainly soon have even better technologies available, to deliver greater levels of productivity and quality. Long live laser cutting research!

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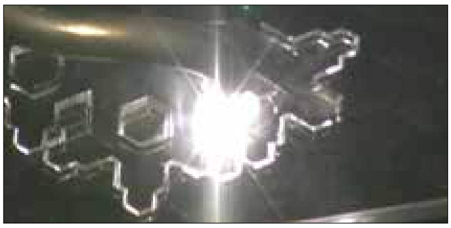
Advice on laser cutting polycarbonate

Responses to a job shop enquiry



Polycarbonate can be cut easily by CO_2 laser. The cutting gas can be air or nitrogen. Trials should be carried out to establish the optimum cutting speed, laser power and air/nitrogen pressure. Pressures of 2 - 6 bar through a 2 -3 mm nozzle should give good results. The cut edge will be slightly darkened by chemical degradation and this cannot be avoided. There may also be a little dross on the lower edge of the cut which can be minimised by controlling the cutting gas flow (try putting the pressure down as well as up)

The big problem is the fume given off during cutting. If you can smell it during cutting you need to improve your extraction system. Treat all laser cutting fumes off plastics as potentially carcinogenic and toxic. This type of fume cannot be filtered (beware: it will quickly clog up the filter you use to trap particulate) and the air cannot be re-cycled back into the workplace even if you're thinking of activated charcoal filters; the rates of fume production are too great.

You need to extract the fumes out of the building to somewhere where people will not be exposed to it. Some firms simply release the fumes at roof level, but this can produce an air pollution (nuisance) issue depending on the volumes of material being cut and the closeness of residential homes or other businesses. Higher level extraction is recommended.

Another element of the fume problem is contamination of the cutting table and fume extraction system, which will eventually be covered in a grey/green candy floss type material. It is a plastic and is therefore a potential fire risk - especially if you subsequently cut metal on the same machine and fill the area with burning sparks and perhaps oxygen too!

John Powell Laser Expertise

Polycarbonate is the material most commonly used for CO_2 laser safety spectacles. For this application the relevant parameters are that it is tough, that it is strongly absorbing at the CO_2 laser wavelengths, and that it chars and discolours when heated by a laser beam - providing the wearer with a warning if one were needed!

We have successfully cut thin (< 2 mm) polycarbonate but find it difficult to cut 5 mm with an acceptably good edge; plus, it produces quite nasty toxic fumes. I suggest you use water jet!

Dave Connaway Cirrus Laser Ltd.

Further reading: 'Dealing with plastics fumes during laser cutting' M Green and J Powell, Issue 15.
Read it on the AILU web site
Log in and click 'The laser user' link to download this and many more safety and technology articles.

Cutting mild steel with nitrogen

John Powell

When laser cutting mild steel with oxygen, the chemical reaction in the cut zone produces a liquid which is easy to blow away because it does not stick to the solid steel. However, the oxidized liquid is not entirely blown out of the cut zone, and a thin layer is left to solidify on the cut edge. The cut edge is therefore covered in a thin, brittle oxide layer, which is not firmly attached to the underlying steel. The lack of adhesion between the brittle oxide layer and the ductile steel is demonstrated in figure 1. Here we can see that the dark grey oxide has flaked off the cut edge in the area where the component was bent as part of the fabrication process – the bright steel of the cut edge has been revealed where the oxide has broken off.

In many cases this flaking of the oxide layer is not important, but problems can arise if the laser/oxygen-cut product is plated or painted. The oxide layer forms an unreliable link between the paint/plating and the steel along the cut edge. Under these conditions, the paint or plating can, at some point, break off with the oxide layer. Although this doesn't happen in many cases, the possibility of it happening has lead to a growth in laser profiling mild steel with nitrogen as the cutting gas. If nitrogen assisted gas is used, the cut edge is not oxidized, and the paint or plating is in direct, firm contact with the metal edge.

Figure 1: A 3 mm thick mild steel item cut with oxygen assistance and subsequently bent.
Note: the flaking off of the oxide layer on the cut edge in the area where the bend took place.

Given the energy assistance to the process provided by the oxygen one might assume that the cutting process would be slowed down by a change from oxygen to nitrogen, but at sections below 3mm this is not the case. A 5 kW laser cutting machine using oxygen will profile 2 mm mild steel at approximately 5.5m/min, but this speed increases to 7.0m/min if nitrogen is used as the cutting gas.

The speed increase for nitrogen is even greater in the case of thinner steel, but at sections above 3 mm oxygen produces faster cutting speeds. When cutting thin section mild steel with oxygen, the laser power employed is only a fraction of the maximum power of the machine. This is the reason why nitrogen cutting speeds are greater at these thin sections – nitrogen cutting employs high laser powers at all thicknesses, and speeds are therefore maximized.

The obvious question here is 'why do we only use low powers when cutting thin mild steel with oxygen?' The answer lies in the sensitivity of the oxidation/burning reaction to changes in the process parameters. Control of the oxidation reaction depends u39pon keeping the cut zone hot enough to burn, but not so hot that the area on either side of the desired cut line burns uncontrollably as shown by the sample in figure 2. If we set the laser power high, then the cutting speed must remain high or else the cut zone will become overheated. Unfortunately, the laser cutting machine needs to slow down to go around corners, or small holes; also when starting or finishing a cut. If we tried to cut thin section mild steel with oxygen at high power, the cut product would become burnt and damaged. We therefore reduce the power and cutting speeds to a level which gives us a good quality cut along the long, faster, straight cuts; and also in the detailed parts of the cut line where the laser needs to slow down.

For the part illustrated in figure 2 the high power of the laser combined with the deceleration necessary for the beam to navigate around the small (2 mm diameter) holes, has caused overheating

Figure 2: Small detail burning in thin mild steel when cutting with too much laser power.

of one of the holes and has made the oxidation process unstable. If the laser power and programmed speed are both reduced, the difference in actual cutting speed between the small holes and the larger features will be reduced, stabilizing the process.

As the thickness of the steel is increased above 3 mm the laser powers can be increased without jeopardizing the cut quality because the process is generally slower at these greater thicknesses. At thicknesses of above 5 mm the laser power is set close to maximum for oxygen and nitrogen assisted cutting, and the extra energy of the burning reaction keeps the oxygen cutting speeds high. Maximum thicknesses for the two processes are also different – in the example described here (using a 5kW laser), we can cut 25 mm thick mild steel with oxygen but only 10 mm using nitrogen.

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The article is taken (with the authors permission) from John Powell's recently published book 'The LIA guide to Laser Cutting - 2nd edition' ISBN 978-0-912035-16-1.

The LIA guide to Laser Cutting - 2nd edition', greatly expanded from the 1st edition, can be ordered from the LIA web site at http://www.laserinstitute.org/. Copies are available from the Laser Institute of America and from AILU at *LIA member rate + P&P*

Micro-cladding with a fibre laser

Torsten Jambor and Konrad Wissenbach

The current state of the art in commercially available systems for micro- laser-cladding use pulsed Nd:YAG lasers and deliver additive material in wire form. Typical laser spot diameters exceed 100 µm [1]. The additive material is fed manually, so the quality and the reproducibility of the cladding process are strongly influenced by the personal skills of the person undertaking the task. Alternatively, a two stage process can be used. In the first step the additive material is deposited/printed on the substrate with a binder and in the second step melted by laser radiation [2].

Some investigations have been made to develop the single step laser cladding process [3], but a systematic investigations to realize structure sizes smaller than 100 µm with iron, cobalt and nickel alloys are still to be reported.

Approach

The investigations at the Fraunhofer ILT aim at a structure size (width) between 20 and 100 µm by laser cladding with powder injection. Figure 1 illustrates the process scheme.

The laser beam creates a melt pool into which the additive powder material is fed. The melt pool is protected by a coaxial shielding gas flow of argon or helium. In this way the oxygen content can be kept below 20 ppm. After solidification the molten material forms a layer with nearly 100 % density and a metallurgical bonding to the substrate.

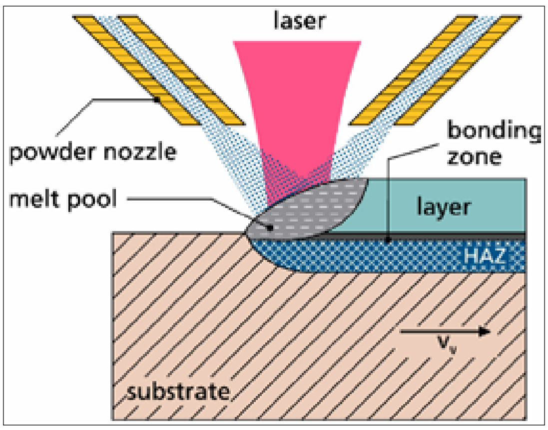


Figure 1: Process scheme for micro-laser-cladding with powder injection (coaxial powder nozzle)

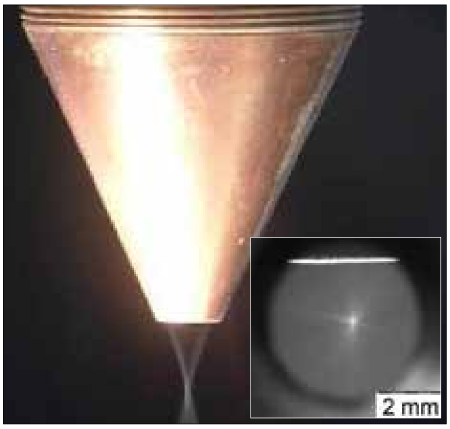


Figure 2: Coaxial powder nozzle and (inset) the powder focus monitored from above

To achieve laser beam diameters well below 100 µm single mode fibre laser systems (from SPI and IPG) were used with output powers between 10 W and 200 W. Using a focusing lenses of 200 mm focus length a focus diameter of order 60 µm was achieved.

In order to guarantee a homogeneous layer quality the powder feeding and focusing was adapted to accommodate fine powders with powder particle diameters smaller than 15 µm. The challenge was to feed amounts of agglomerated powders smaller than 0,2 g/min homogenously with gas flows smaller than 3 l/min. The deposition of the powder material into the tubes and other parts of the powder supply had to be avoided, since the powder forms bulks of agglomerated particles that reduce the cross section of the tube and thereby cause an increase in the velocity of the gas stream. At these higher velocities agglomerated material can be swept away and deposited into the melt pool in an uncontrolled way.

Figure 2 shows the nozzle depositing fine powder. The diameter of the powder focus depends strongly on the powder material, the geometry of the powder particles and their size distribution, the design and quality of the powder nozzle and the gas volumes of the transport and the coaxial shielding gas stream. The smallest powder focus core diameter was about 200 µm, achieved with 316L powder with a particle size between 1 and 8 µm. The powder focus in the inset of figure 2 was taken with the CCD camera of the cladding head. In order to improve the powder and therefore the process efficiency, an important aim of further investigations will be to reduce the powder focus diameter to significantly less than 100 µm.

The laser radiation and the additive powder material were guided to the cladding head shown in figure 3. It comprised a fibre plug, optics, CCD camera, powder nozzle and adjustment unit for powder nozzle.

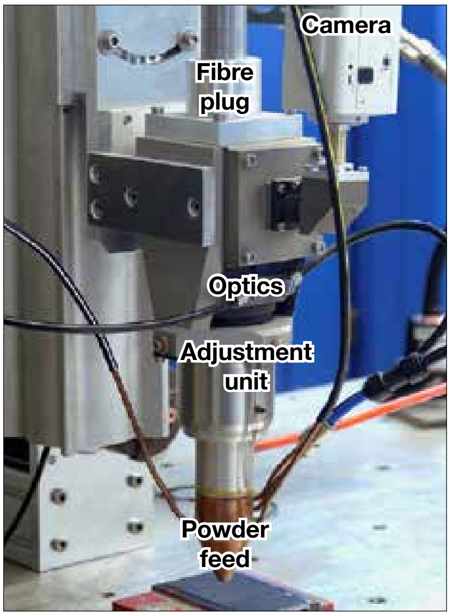


Figure 3: Cladding head for laser micro-cladding

Results

The first experimental results were achieved with 316L on polished stainless steel substrates. Track widths down to 45 µm wide and 10 µm high were achieved.

Figure 4 shows a cross section of a single track and a layer of 20 single tracks with an overlap of about 50 %. By overlapping in this way layers with nearly 100 % density could be realised. In the example in figure 4 the height of the layer is about 10 µm, the re-melting depth about 7 µm. An analysis using white light interferometry (figure 4c) shows a homogenous surface topography.

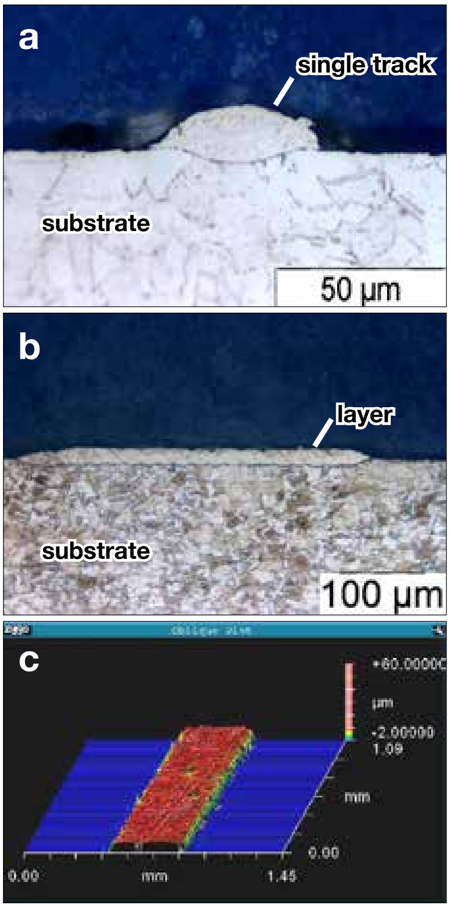


Figure 4: First experimental results. (a) Cross section of a single track made from 316L on a polished stainless steel substrate (P= 14 W, v = 500 mm/min, $Ø_L$ = 60 µm); (b) Cross section of a layer made from 316L on a polished stainless steel substrate; (c) Analysis of layer topography with white light interferometry

To demonstrate the stability of the process, especially the powder feeding and focusing, bars with a width of 90 µm and a height of 900 µm were manufactured in Stellite F. The bar shown in figure 5 comprises 50 single tracks, each with a layer height of 15 µm. In order to achieve a constant width over the whole height of the bar, the laser power had to be reduced after a few layers to accommodate for the change in the heat flow conditions from 3 dimensions (at the substrate) to 2 dimensions.

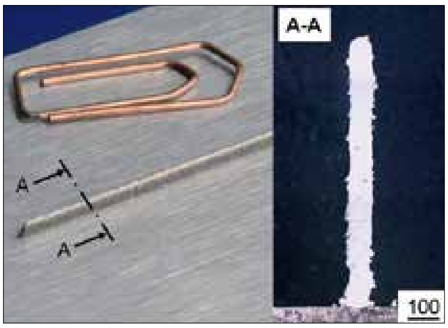


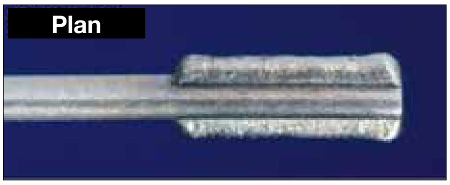
Figure 5: A bar made from Stellite F (cobalt alloy) with a width of 90 µm and a height of 900 µm

As shown in figure 5 the cross section of the bar and substrate is consistent with a very good metallurgical bonding of the bar to the substrate and shows a constant width over the whole height of the bar. Nevertheless, the surface quality of the deposited material has to be improved and spillings have to be reduced.

Potential Applications

Micro-laser-cladding with powder injection can be used to add material to components with small dimensions. Some potential applications are shown below.

Hole stamp



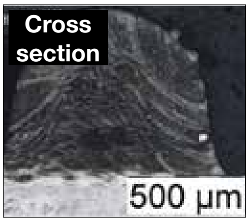


Figure 6: Bar made for a stamp tool from Stellite F (cobalt alloy) on hardened steel. (above) Six tracks per layer, 7 layers; overall dimensions (h x w x t) 700 x 950 x 56 µm.

A hole stamp in hardened steel is shown in figure 6. In this figure two bars made of Stellite F powder (cobalt alloy) have been created using particles of diameter less than 20 µm consisting of 6 tracks per layer with an overlap of 50 %. By cladding 7 layers with a layer height of 100 µm each, the bar height of 700 µm is achieved. After cladding, the bars were grinded or milled to the final dimensions of 500 x 700 µm.

Radiopaque markers on stents

Micro-cladding has been used for the generation of radiopaque markers on stents made of nitinol. Because the X-ray visibility of nitinol is insufficient to allow the position of the stent to be defined during its implantation into the human body, markers made of gold, platinum, tantalum or other materials with high X-ray cross section are fixed on the stents. Figure 7 shows the SEM picture of the stent with the markers deposited and and the X-ray photograph of a stent cladded with radiopaque markers on its ends.

The challenge of this application is to deposit layers with thickness sufficient X-ray visibility onto substrates with a thickness smaller than 200 µm, while at the same time avoiding distortion and

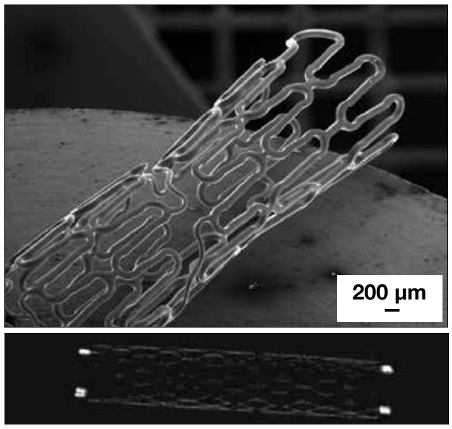


Figure 7: (top) SEM picture of a stent (courtesy Angiomed) and (bottom) X-Ray visibility of a stent with radiopaque markers made by laser micro-cladding

keeping the thermal input into the substrate as small as possible.

Electrical contacts

Figure 8: A switch with a silver contact made by laser micro-cladding

In the electronic industry electroplating is the process most commonly used to reduce electrical resistance in the switches used in mobile phones and other low voltage circuits. The precision of the electroplating is very high, and gold layers of thickness less than 1 µm can be achieved. Compared to the electroplating process, laser micro-cladding allows a more selective deposition of material on electronic components and can thereby reduce the amount of valuable (gold, silver) additive material.

Figure 8 shows a switch component with a silver contact in the middle made by laser micro-cladding. Normally the complete visible surface of such components would be electroplated.

The higher the price for the additive material, the greater the potential cost reduction. End plates and bipolar plates for fuel cells use gold contacts in order to reduce the transition resistance between the metal plate and the membrane electrode assembly. In an initial investigation gold contacts have been

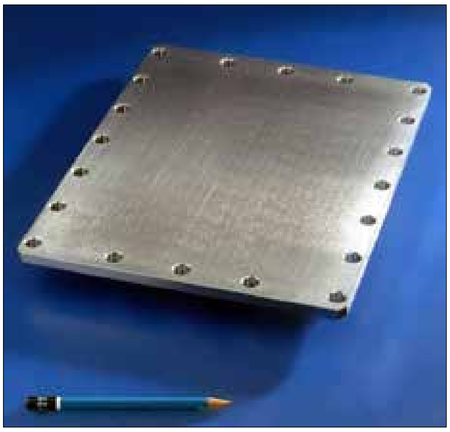
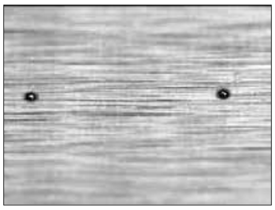
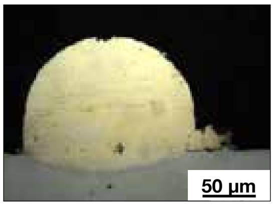


Figure 9: Fuel cell collector plate with gold contacts (Courtesy FZ Jülich)

Top left
Gold contacts on a 4 mm pitch.

Bottom left
Cross section of a contact





cladded on steel substrates. The contacts, had a width of 160 µm and significantly reduced the transition resistance.

The aim of ongoing investigations will be to further reduce the contact dimensions and the dilution with the base material, in order to save material when compared to alternative cladding processes, at the same time preserving the electric properties of the gold. Figure 9 shows the collector plate of a fuel cell clad with gold. Using this process 1500 contacts were added to the plate with a distance of about 4 mm between the contacts.

System Engineering

Laser micro-cladding has the potential to become a useful technique in the mould industry for the repair and the modification of moulds for micro injection moulding. These moulds often consist of up to 48 cavities, such as the example shown in figure 10. Periodic geometrical defects (such as worn edges) will develop during use of the mould; such wear may be greatly reduced by adding a thin layer of a hard wearing alloy. In such cases automated laser micro-cladding with powder injection has clear advantages over manual laser cladding process with wires.

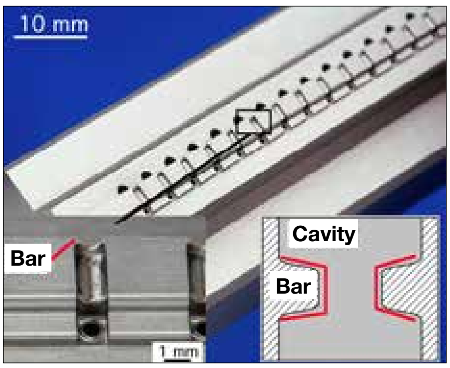


Figure 10: Mould for micro-injection-moulding

The task of automation in this case is to clad all sides of the bar in each of the 48 cavities with a 100 µm thick layer without destroying the contour of the bar and with minimum heat input to the substrate. The approach we adopted was to programme the path of the cladding head off-line and than transfer the programme to the CNC control of the handling system. In this way a homogenous cladding result can be assured in each of the 48 cavities.

An important requirement if homogenous cladding of 3D surfaces is high precision. In cooperation with Sitec Industrietechnologie GmbH a high precision 5-axis handling system (position accuracy ± 1 µm) for the laser micro-cladding process has been designed and in now in the realisation phase. The concept involves a work station with 3 linear and two rotatory axis.

First tests of the handling system will take place after implementation of the cladding head.

Conclusion

The laser cladding process allows selective deposition of material but current techniques are unable to realise structures with a width smaller than 100 µm and a height smaller than 10 µm.

However, by using fibre lasers and powders with particle diameters smaller than 15 µm, the minimum achievable structure size for the laser cladding process can be significantly reduced: we have demonstrated that a width smaller than 60 µm and a layer height of less than 20 µm can be realised. The powder feeding and guiding have been adapted for agglomerated powders, but still the process stability has to be improved to fulfil serial production requirements and the powder focus diameter has to be reduced in order to increase the powder efficiency and therefore the process costs.

In further investigations the influence of different process parameters (e.g. laser power, powder mass flow and velocity) on the cladding result will be quantified and the process will be optimised with regard to the cladding geometry, dilution with the base material and functional properties. The aim of future projects will be to reduce the minimum achievable structure sizes to a width smaller than 25 µm and identify suitable variables and techniques for process monitoring and control.

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Picosecond lasers and their industrial applications

Gerry Jones

The use of laser technology is now well established in many industry sectors. In almost all cases its use has been based upon the laser being a thermal processing tool. It has proven itself to be a truly efficient, accurate and productive tool particularly when the laser interaction is precisely controlled. However, with the advent of ultra-short pulse lasers so-called 'cold processing' is possible i.e. material removal with negligible residual heating. Such processing is very attractive for certain applications, including expanding markets such as the manufacture of semi conductor and solar panel components.

For metals, semiconductors or dielectrics the electron to atom energy transfer time is in the order of 10 picoseconds. If the laser is to process the material with negligible mechanical and thermal modification then the laser pulse duration must be less than this. When this is achieved material is removed by sublimation.

Few commercial lasers provide such short pulses, those that do have generally been limited to very low average powers, typically less than 10 watts. These lasers produce good results but their low average power implies slow processing and in general productivity is deemed to be insufficient for widespread industrial acceptance. The advent of the Trumpf TruMicro 5050, a picosecond laser built for industrial use with high reliability and an average power in excess of 50 W provides the required throughput to be a cost effective tool.

Laser technology

The Trumpf TruMicro 5050 produces pulses of width < 10 ps at an average power of > 50 watts. The laser exit beam is diffraction limited and has a roundness of over 95%. The laser design is based on a diode pumped disk used as power amplifier. The output power is set not by adjusting the pump power, but rather by precise switching and attenuation of the pulses outside of the resonator, by a so called external modulator. In this way the output has high stability and a fixed concentric beam profile which is independent of the actual output laser power. By maintaining a constant power the "first pulse" problem, an historic issue with such short pulse lasers where the first pulse produced is irregular, has been overcome.

Applications in semiconductor manufacturing

In 2007 the semiconductor manufacturing industry made circa $250 billion gross revenue and invested over $40 billion in new equipment. The demand for cheaper and increasingly powerful end products, such as PCs, laptops and MP3 players, is the driving force for further development of production equipment.

The process flow in semiconductor manufacturing is commonly divided into the front-end and the back-end section. The front-end production line contains all processes for forming integrated circuits (ICs) directly on silicon wafers. Typical steps are depositioning, patterning, removal, doping and activation plus several inspection steps. Here, lasers are used for selectively patterning a thin film by mask projection instead of direct laser ablation.

Innovation in the front-end process chain is driven by Moore's Law, which predicts that the number of transistors on a chip will roughly double every two years. To keep pace with scaling and IC density changes on the front end, technology advances lead to new trends in the back-end section.

The back-end of the production line typically starts with the grinding the back side of the wafer. During the grinding process the thickness of the silicon wafer is reduced from about 600-700 µm to 100 µm or even thinner. Whereas a thicker silicon wafer is an advantage for the wafer stability in the front-end, it becomes a drawback for the up coming packaging procedure. Packaging means separating and mounting the individual dies (chips), connecting the die to the pins or bumps of the package (i.e. by wire bonding) and encapsulating the bonded die. Within each of these these steps there is a strong drive to reduce the thickness of the silicon. Smartcards for example, are thin pocket sized cards containing a chip with integrated circuits. They require thin IC chips; so too do SD memory cards.

'Cold' laser machining

3D packaging – Through Silicon Vias

Latest trends in packaging try to accommodate Moore's Law by going into the z direction. This expansion means stacking two or more dies to reach higher performance per chip area. Established 3D packaging technology is using wire bonding to connect the stacked dies to the package. At the present time the connections on such a batch are placed around the perimeter of each die, which sets a fundamental limitation to the area of the top dies. Further limitations of this technology are set by crosstalk and speed losses due to the fact that wires used for bonding can act as antennas.

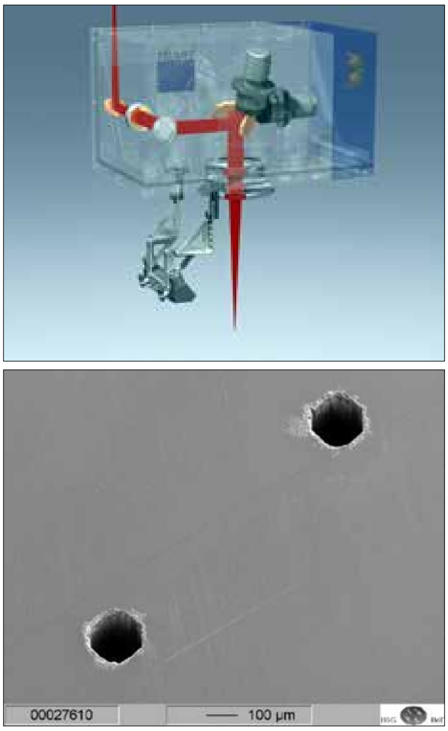


Figure 1: Principle of rapid TSV drilling using XY beam steering via galvanometer driven mirrors; (lower) samples of drilled holes in silicon

A way to overcome these obstacles is by making short, direct connections through the silicon substrate of each die. For this purpose blind holes, so called Through Silicon Vias (TSVs), are drilled into the silicon either prior to the front-end processes (via first) or after the front-end processes (via last). For via first, these blind holes are coated with an isolating layer and filled with conducting material. After the front-end steps are complete, the silicon wafer is thinned (ground), and this opens the blind holes and forms the connections to the backside.

Today, the most common process for generating TSVs is Deep Reactive Ion Etching (DRIE), which allows for high aspect ratio blind holes with low surface roughness. However, the DRIE process requires a vacuum environment and the use of expensive masks. Due to parallel processing of all TSVs on a wafer, the processing costs when using DRIE remain constant. Only for a very large number of vias per wafer DRIE does become economical.

The advantage of using lasers for TSV drilling is the lower purchasing cost, because neither vacuum nor lithography or masks are required. The lower running costs due to fewer consumables is another advantage of laser drilling. Furthermore, the laser process is very flexible when changes in TSV layout are required. The technique and some TSVs are shown in figure 1.

The use of high average power and high pulse energy picosecond lasers enables for TSVs without heat affected zone. For these lasers, only a combination of sufficiently high pulse energy combined with high pulse repetition rate in the order of 200 to 500 kHz allows for a high throughput.

Wafer Dicing

Diamond blade saws can be used to separate individual dies from a wafer; the separated dies then being picked and placed into lead-frame packages. However, the thin silicon wafers present a major challenge for blade saw dicing machines. Due to the mechanical contact, wafer saws have to operate very carefully to avoid breaking the die or producing chips along the cutting edge.

The laser as a non-contact is faster at dicing than the blade saw tool for die-singulation. A further advantage of using ultrashort pulsed lasers is the high cut quality and the negligible heat affected

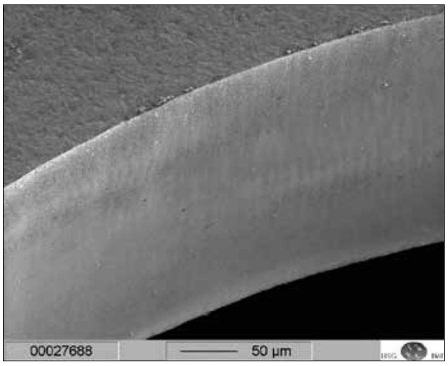


Figure 2: Laser-cut edge of a 300 µm silicon wafer

zone. This leads to cutting edges with high tensile stress, an essential factor if the die is to sustain mechanical load during the following processing steps, see figure 2.

Another advantage of the laser over the blade saw is that the narrower kerfs can be achieved (less than 20 µm for the laser, typically 120 µm for the blade saw), which reduces the “dead space” on the wafer and increases the number of dies per wafer.

A third big point for the laser results from a trend toward new dielectric materials that are used as insulators inside a chip, separating the conducting interconnections from each other. As structure sizes get smaller and integrated devices such as transistors get closer, the thinner insulating dielectrics are needed. Such thin inter-level dielectrics cause capacitive losses proportional to their dielectric constant k. Silicon dioxide, with a k of 4, is the commonly used material for this application; and there is a drive to move to 'lower-k' materials of the same thickness, which would result in a higher chip performance with less power consumption compared to silicon dioxide.

Low-k materials are typically more brittle and have a lower adhesion than silicon dioxide. This increases the risk of chipping and delamination of the low-k layers when a blade saw is used for the wafer dicing process. Using ultrashort pulsed lasers enables high speed and high quality scribing of these low-k layers without the drawbacks of a mechanical treatment. This low-k scribing can either be combined with a subsequent full laser wafer cut or with dicing by blade saw.

All the above described points show that the technological trends in chip manufacturing make ultrafast lasers with high average power and pulse energy an advantageous tool for wafer dicing. The quality that can be achieved with such a laser is shown in Figure 2, where the cutting edge of a silicon wafer with a thickness of 300 µm is shown. Even under SEM, no chipping or heat affected zone can be detected. This supreme cutting quality enables a higher yield than the blade saw which more than compensates for the investment in laser technology.

Package Dicing

After singulation, the die pads are connected to the pins on the package by wire bonding. The is followed by encapsulation with mold compound, which seals the die. The resulting matrix leadframe with packaged chips then has to be singulated either by blade saw or laser. The advantage of using picosecond lasers for this application is the low heat affected zone. The entire material mix can be cut in one process with superior edge quality.

Applications in thin layer solar cells

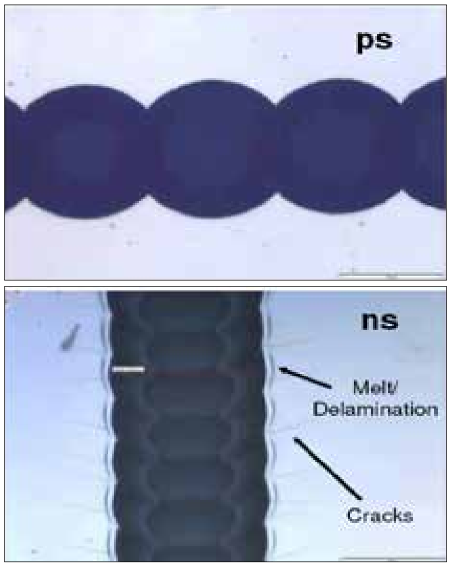
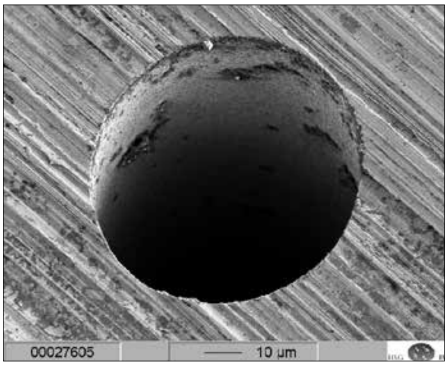


Figure 3: Removal of a 0.5 µm thick molybdenum layer on a glass substrate: (top) with picosecond pulses with no visible defects; (lower) with nanosecond pulses showing damage

In the production process of $Cu(In,Ga)Se_2$ (CIGS) thin layer solar cells there are three structuring processes for the serial cell connection. Figure 3 shows the removal of a 0.5 µm thick molybdenum layer on a glass substrate. Using nanosecond pulses, molten material, crack formation and delamination are visible on the edge of the scribed groove. Using picosecond pulses, neither burr nor molten material formation are visible along the laser-structured groove and there is no sign of delamination.

Applications in small high accuracy hole production



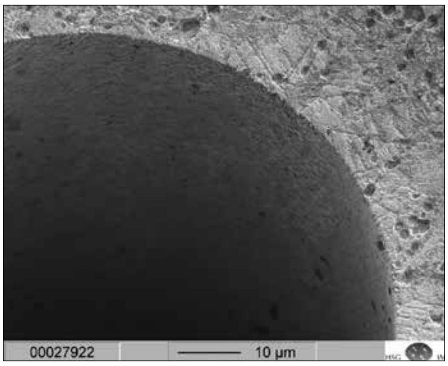


Figure 4: High accuracy hole drilling: (upper) in case hardened steel; (lower) in structural steel, showing no heat affect, melt or debris.

Applications for small, high accuracy hole production by picosecond lasers have also been realised e.g. in the manufacture of automotive injector nozzles. This application has been a goal for many years within the laser field; but melt reformation, surface roughness and speed of throughput have been barriers. The TruMicro 5050 has allowed automotive engineers to revisit this challenge with successful results, see figure 4.

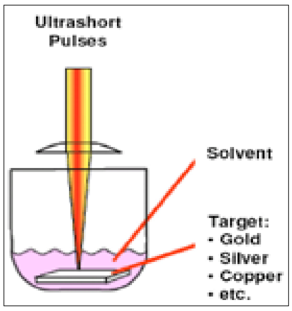
An additional major benefit is the fact that the laser is not limited to producing round holes - any desired geometry can be cut, including conical holes with a positive or negative wall taper. This flexibility in hole production gives the automotive design engineers new opportunities to increase the efficiency of the injector nozzle and hence reduce fuel consumption.

Production of Nanoparticles

When picosecond laser pulses are focused onto a target metal such as gold nanoparticles are produced. These particles are collected in a solvent, typically water and later removed. The TruMicro 5050 allows for this process to be carried out in volume at a generation rate not previously possible; see figure 5.

Typical applications can be found in the medical industry, such as creating bioactive implants. Here implants or medical instruments are coated with silver or copper Nanoparticles, resulting in an antibacterial surface.

Figure 5: Production of nanoparticles: (left) Schematic view; and (below) sets of different nanoparticles produced by the TruMicro 5050



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The slow uptake of laser welding

A review of the AILU Members' Meeting and AGM on 8 April 2008 at Cranfield University

AILU's 14th Annual General Meeting took place at Cranfield University on the morning of 8 April as part of a day that also included a general technical meeting and a tour of the Welding Centre and the Precision Engineering Centre. The minutes of the AGM are enclosed with this copy of the magazine and can be found in documents library on the AILU web site; the presentations of the AILU Award and Prize can be found in the AILU news on page 1.

Stewart Williams, Professor of Welding Science and Engineering, chaired the first part of the members meeting, comprising presentations and open forum discussion. After a joint presentation on new developments at AILU by Mike Green and Anna O'Neil, David Yapp, senior lecturer at Cranfield, addressed recent developments in welding, mainly outside of lasers. The latter provided an excellent introduction to the open forum discussion on 'How well do lasers currently compete with non-laser sources for welding?' that followed.

Leading the discussion, Stewart pointed out that laser welding has had a slow uptake and is not the preferred choice in most cases. There are some obvious reasons for this, including cost and gap tolerance, but part of the problem seemed to be the conservative approach of UK manufacturing industry: the uptake of laser for welding is much greater in Germany than the UK, and David Yapp pointed out that Fronius, a supplier of advanced hybrid laser-arc welding heads, had sold 200 in Germany and Austria and none in the UK!

Another reason laser welding is not more popular is that, compared with arc welding, it is much further away from having a 'plug and play' capability; there remains too much of a 'black art' about it.

Martin Sharp (LLEC) pointed out that engineers leaving college have insufficient knowledge of laser processing. Jim Wright suggested that AILU should consider presenting a (life cycle) comparison of laser welding and the alternatives.

Courtesy Trumpf

Geert Verhaeghe (TWI) claimed that "laser processing still isn't on the radar for lots of engineers" and there was a general view that indeed AILU should take the lead to promote laser technology in this area, and that there are many people who would be willing to assist if AILU needed help. Actions included 'beating on the door' of laser users and suppliers for information but, pointed out Stewart, the laser process information needs to relate to the correct parameters, rather than speed and thickness (see ''Opinion' in Issue 50, page 25).

By way of final comments, John Bishop considered that laser welding today is where laser cutting was 15 years ago when Make It With Lasers was trying to promote it, and Neil Main (Micrometric) observed that cutting machines are a lot simpler than ones for welding!

Two-photon polymerisation: technique and system

Sven Passinger, Aleksandr Ovsianikov, Andreas Ostendorf, and Boris N. Chichkov

Rapid progress in the performance of ultra-short pulse laser systems has created exciting possibilities for two-photon polymerisation (2PP), a promising 3D microfabrication method that requires high and precise localization of femtosecond laser pulses in both time and space.

As can be seen in Figure 1, which shows an example of what can be achieved by 2PP, the process offers high resolution and the capability of real 3-dimensional structuring, providing unprecedented freedom in the fabrication of complex micro- and nanostructures.

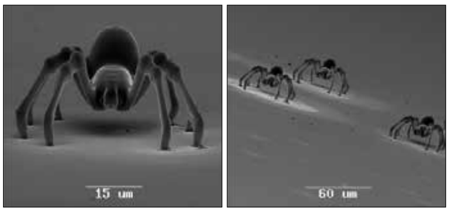
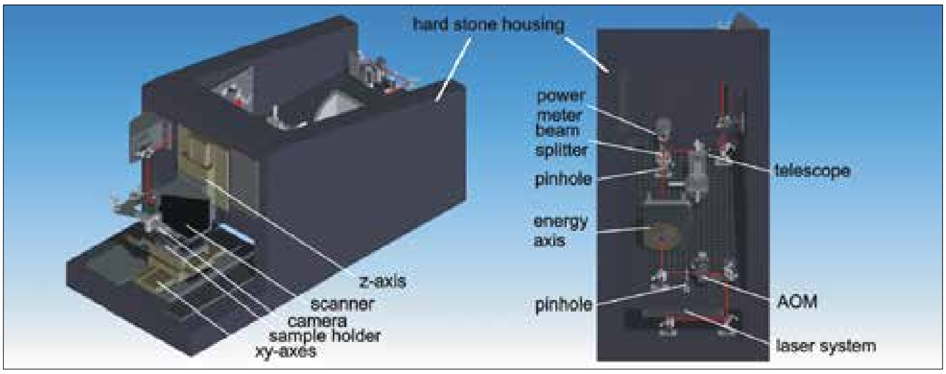


Figure 1: Scanning electron microscope (SEM) images of spiders fabricated by 2PP

Benefits of the two-photon process

In operation 2PP is somewhat similar to that of the traditional stereo-lithography technique, but provides much better structural resolution and quality. In each case the process involved is the curing of photosensitive materials; the critical distinction is in the mechanism by which the laser beam initiates the process. In the case of 2PP the process employs near infrared laser beams and requires the simultaneous absorption of two photons, whereas in traditional stereo-lithography a laser beam is used and the process is initiated by the absorption of a single ultraviolet photon. Because many photosensitive materials are transparent in the near infrared and are highly absorptive at ultraviolet wavelengths, one can initiate polymerisation with near infrared laser pulses within the volume and fabricate 3D structures, whereas with ultraviolet laser radiation polymerisation occurs at the surface. Conventional UV-photoresists such as ORMOCER®s or SU8 are also suitable materials for 2PP. To fabricate 3D structures in these materials by stereo-lithography a layer-by-layer approach must be used, whereas with 2PP the approach is truly 3D and high-resolution, making it very attractive for rapid micro-structuring.



The high-resolution capability of 2PP is a result of the non-linearity of the process by which the photo resist simultaneously absorbs two photons. As a result, a resolution beyond the diffraction limit can be realized by controlling the laser pulse energy and number of applied pulses. Resolutions better than 100 nm are achievable with this technique.

Practical implementation

The Ti:sapphire femtosecond laser oscillators working in the near-infrared at around 800 nm is a suitable laser source for 2PP. A computer controlled positioning systems is also required, one of sufficient accuracy to realise the high resolution inherent to the 2PP process. Piezo stages and/or scanners are clear options but both have drawbacks. The drawback of piezo stages is their small travelling range, typically a few hundred micrometers in each direction. To use a scanner in this application, movement of the writing laser beam is produced by deviating it through a focusing microscope objectives, but this leads to distortions of the focus in the outer parts of the image field and thus, to a loss of intensity and structure homogeneity.

The "Micro-3-Dimensional Structuring System" (M3D) is an autarkic system designed to generate micro- and nano-scale 3-D structures. Developed at the Laser Zentrum Hannover e.V. it overcomes the limitations of piezo stages and scanners by integrating the femtosecond laser with a scanner for fast writing of small area structures and an air baring linear motor drive positioning system.

Figure 2: The M3D machine: (above) CAD drawing of the M3D and (right) a photograph of the realized system

Two lasers have been used with the M3D, though other laser systems can also be integrated. These lasers are: (i) the femtoTRAIN IC from High Q (200 mW average power, 800 nm wavelength, pulse duration < 100 fs, repetition rate 73 MHz); and (ii) the t-Pulse 20 from Amplitude Systems (0.5 W average power, 515 nm wavelength, pulse duration < 150 fs, repetition rate 50 MHz).

The M3D positioning system comprises three Aerotech ABL 10100-LN linear axes (which provide an overall travelling range of 10 cm in all three dimensions) and, for structuring curved cylindrical substrates, a ADRT-100 rotational axis. The accuracy of scanner based writing is better than 100 nm, while the positioning accuracy over the complete travel range is better than 400 nm.

The front view of the 3D structuring system is shown in Figure 2. The top image is a CAD representation and the bottom image is a photograph of the realized system, which is now commercially available as an industrial tool. A reduced version of this system for research laboratories is available; this system can be placed on an optical table and integrated with a laser system and beam conditioning components.

Applications of 2PP

2PP addresses a wide range of applications. Figure 3 shows some examples of applications of fabrication in micro-optics and photonic crystals ranging from micro-prisms to components of arbitrary shape. These structures have a good surface quality sufficient for optical applications.

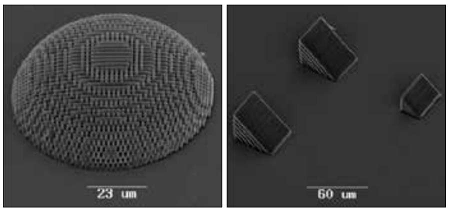


Figure 3: SEM images of a photonic crystal in a lens shape (left) and micro-prisms (right) fabricated by 2PP

One of the main advantages of 2PP compared to other fabrication technologies is the high flexibility in the fabrication of arbitrary shapes and whole micro-optical circuits in one production step. 2PP also provides novel possibilities for design and realization of 3D components in the area of micro-mechanics as illustrated in figure 4, where the design and a few examples of the fabricated micro-mechanical components are shown.

Biomedical applications

There are many very promising bio-applications of 2PP technique: for tissue engineering, drug delivery, medical implants, and sensorics.

For tissue engineering, the ability to produce an arbitrary 3D scaffold structures is very appealing. Scaffolds are required

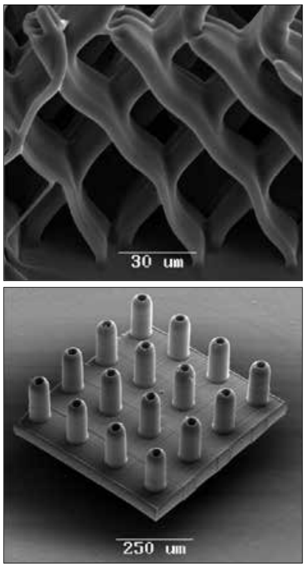


Figure 5: SEM images of a scaffold structure (top) and free-standing Lego® type structure for cell growth experiments (bottom) produced in ORMOCER® by 2PP

for the artificial fabrication of living tissue that will be able to integrate with the host tissue inside the body; a very challenging task. The precise control of 3D geometry available with 2PP makes it possible to model and reproduce the cellular micro-environment within the scaffold. Furthermore, the high resolution of 2PP can be used to provide control over the cell organisation inside the scaffold and consequently, over the cell interactions.

An example of a potential scaffold structure is shown in figure 5 (top). In the bottom figure an SEM image of a free-standing Lego® type structure fabricated for cell growth experiments is demonstrated.

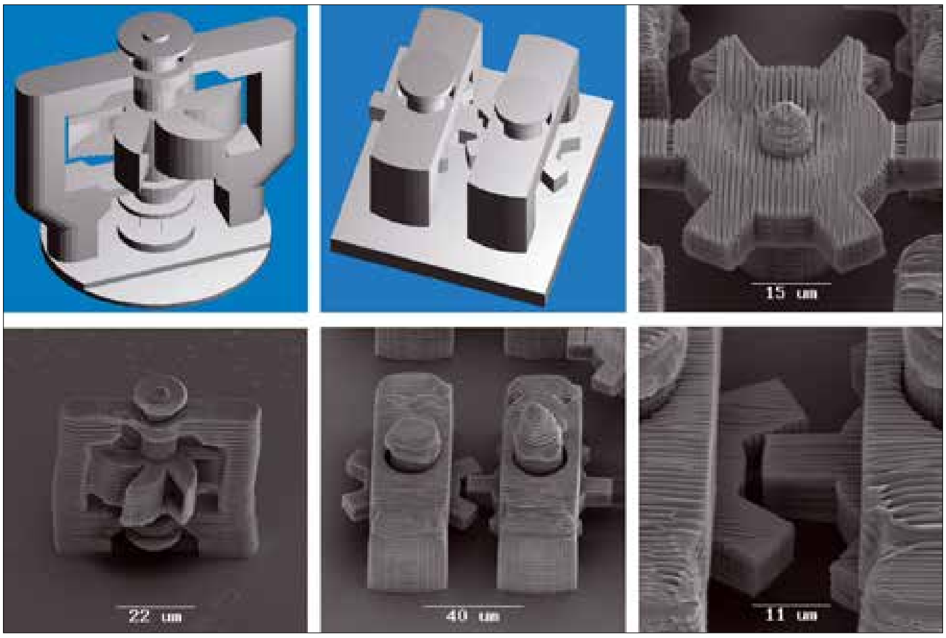


Figure 4: The design and SEM images of the fabricated micro-mechanical components

2PP can also be applied for the fabrication of drug delivery devices, such as micro-needle arrays. These devices enable trans-dermal delivery of a wide diversity of pharmacological agents, and may overcome many issues associated with the conventional intravenous drug administration, including pain to the patient, trauma at the injection site, and difficulty in providing sustained release of a pharmacological agent. Moreover, the flexibility of the 2PP technique makes it possible to perform arbitrary changes to the needle design and therefore to compare the effect of the geometry on the mechanical and puncturing properties.

Figure 6 shows an example of micro-needles for drug delivery fabricated in ORMOCER® by 2PP. These micro-needles exhibit appropriate mechanical properties and can penetrate skin without fracture. Investigations of these microneedles arrays for drug delivery are in progress.

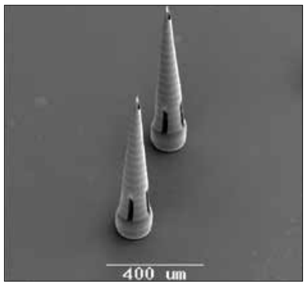


Figure 6: Micro-needles fabricated by 2PP

In addition to the small scale structures featured here, relatively large structures can also be fabricated. Recent advances in the 2PP technology achieved at the LZH has increased the writing speed from typical 100 µm/s to 30 mm/s. This drastic increase in the writing speed makes possible the fabricaton of large scale (up to 10 cm side) 3D structures including as stents and complex bio-medical implants.

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A new method of laser beam induced surface modification

Paul Hilton and Ian Jones

Surfi-Sculpt® is a power beam process, invented at and patented by TWI, which enables controlled surface features to be developed on a range of substrates, including but not limited to metals, polymers and ceramics. Such surface features were first demonstrated using electron beams, employing electromagnetic coils to first focus the beam and then deflect this focused beam over the material surface in a rapid and controlled manner. This article will describe more recent work, which has involved the use of focused laser beams to develop similar features.

The process

Fibre delivered laser beams and galvanometer driven scanning mirrors were used in this work to produce the rapidly moving spot of laser energy required for the process. After generation of a molten pool in the substrate material, the beam is then rapidly moved relative to the workpiece. As a result of vapour pressure and surface tension effects, the laser beam movement results in material being moved from within the pool to regions at the extreme end of the beam movement. By repeating this process, it is possible to build up protrusions of several millimeters in height above the surface of the material. By combining and sequencing these protrusions together, a variety of shapes or features can be formed.

The laser experiments have been performed in air and in various gaseous environments and, for comparison purposes, with electron beam work, in vacuum. The technique is not limited to the production of protruding surface features; it can also be used to modify the structure deeper within the work-piece, so as to effect modification in the bulk substrate, for example, by the creation of deep holes in the material.

The types of surfaces produced are being investigated for many applications, including orthopaedic implants, with improved fixation due to promotion of bone in-growth, preparations for metals to be joined to composite, and for making surface features that enhance thermal transfer for high performance heat exchangers.

Investigations

In the results reported here, both disc and fibre lasers have been used at relatively modest laser powers of less than 2kW, in conjunction with two different laser beam scanning systems, both developed primarily with laser welding applications for the automotive industry in mind. The disc laser was manufactured by Trumpf and the fibre laser by IPG Photonics. The scanning systems were manufactured by Trumpf and Arges.

Trials were conducted on both metal alloys (Ti-6Al-4V) and plastics (polypropylene and polyethylene). For all materials, initial work consisted of producing simple linear shapes, using a repeated 'swipe' of the focused beam across the surface of the material. The main process variables were laser power, swipe speed, swipe length and the dwell time between swipes. Subsequently, more complex shapes were attempted, by combining several single swipes together to form a pre-determined pattern. For both the Trumpf and IPG laser systems, the minimum focused spot size was estimated to be between 0.3 and 0.34 mm in diameter

Metals

Figure 1 shows typical preliminary results of using a laser beam to generate a conical type Surfi-Sculpt feature in titanium plate, using a 'star' form for the swipe pattern. The sequence consists of repeats of eight radially sequential single swipes. These results were obtained in air and did not use the vacuum normally required for electron beam work.

The processing conditions, as given in the figure caption, were determined from optimisation trials on single swipes. Initially the star shaped pattern was generated with no 'gap' in its centre. This condition resulted in a protrusion which was not particularly conical. The improved shape seen in Figure 1, was

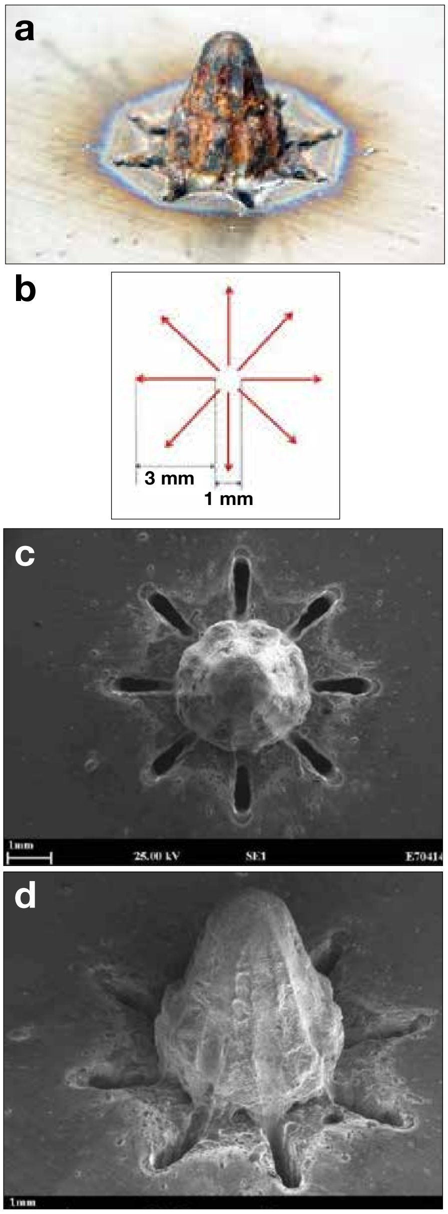

Figure 1: Conical Surfi-Sculpt feature created in air on a titanium alloy plate.

(a) Photograph of the feature

(b) Diagram. The arrows indicate the direction of the movement of the laser beam. The sequence consisted of repeats of eight radially sequential single swipes. (NB Note the 1 mm gap in the centre)

(c) and (d) SEM images

The operating parameters were:
laser power = 1 kW
scanning speed = 16 m/min
number of swipes per arm = 60,
time delay between swipes = 0.5 ms.

The total time required to create this star shape was approximately 5 s.

produced with a gap of about 1mm in diameter in the centre of the pattern. High speed video of the process showed this to be beneficial to the cyclic nature of the build up of the material. It also indicated the possibility of the structure being hollow inside, at its base. Also seen in the SEM images are the swipe terminations and the slots below the surface, from which the material moved to make the protrusion. Clearly, several sets of this particular feature could be put together to form an array on the material surface. In this case the height of the protrusion was about 5mm, and its manufacturing time was about 5 seconds, using a laser power of about 1kW.

Plastics
It is very difficult to process plastic materials using electron beams and another driver for the laser work was to see if the process would work on these materials using laser beams. This has been demonstrated on polypropylene using a CO_2 laser, and on polyethylene using a fibre laser source, although the only results shown here are for polypropylene.

Figure 2. Surfi-Sculpt feature made in polypropylene using a few Watts of CO_2 laser radiation.

Figure 2 shows an attempt to reproduce the star shape shown in Figure 1, in polyethylene, at much reduced laser power. It can be seen that the process appears to work with plastics, notwithstanding the large difference in viscosity between molten plastic and molten metal.

Atmospheric conditions
A small hermetic chamber was used in order to study the effects of atmospheric condition when processing metals. The same programmed laser beam path shown in Figure 1 was used to create features in a 100% argon atmosphere, as well as in air, all on the same titanium plate. The process parameters were kept the same as those shown in the caption to Figure 1, except that only ten swipes per arm of the star shape were employed, instead of sixty.

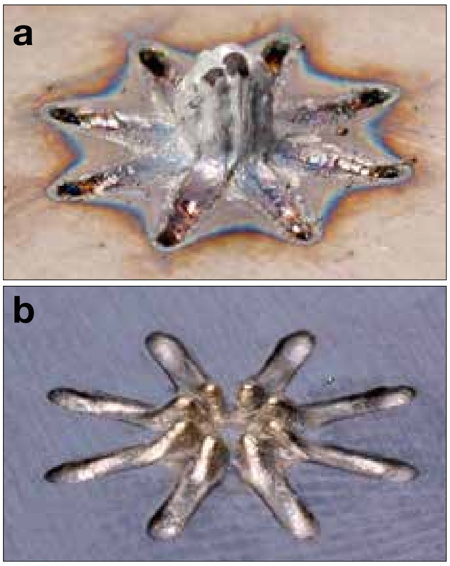

Figure 3. Photographs of Surfi-Sculpt star shapes in titanium alloy made in a) air, b) in argon.

The operating parameters were:
laser power = 1 kW
scanning speed = 16 m/min
number of swipes per arm = 10,
time delay between swipes = 0.5 ms.

The total time required to create each of these star shapes was approximately 1 s.

The results of this experiment can be seen in figure 3. The only change between the two pictures is the atmosphere around the sample. It can be seen that the feature size in air, (figure 3a) is the larger but the feature does not have a smooth surface and there is evidence of spatter and significant oxidation with some heat marking of the substrate surface, whilst in a 100% argon atmosphere (figure 3b) there is practically no evidence of heat marking, oxidation or spatter and the Surfi-Sculpt shape very closely represents the actual programmed path of the laser beam insomuch as the ‘gap’ between the linear swipes is quite obvious, which is not the case for the result in air. These effects are probably associated with differences in the thermal conductivity of the two processing environments and its effect on the viscosity, movement and solidification of the material during the process.

Potential Applications

Orthopaedic implants
The surface of orthopaedic implants can be modified to improve the fixation of metallic implants by encouraging bone in-growth. There are alternative techniques for making these surfaces, but a Surfi-Sculpt process offers the potential benefits of being fast, of allowing close control of the feature shapes and of ensuring surface features are firmly bonded so that they do not detach from the implant.

The general social trend for increased life expectancy and an expectation of people to be mobile and active in old age is reflected in the market for orthopaedic implants worldwide increasing at 7% per annum. In 2005 the total number of hip or knee replacements in US and Europe was 814,000. It is estimated that 10% of these will fail – the overwhelming majority because of aseptic loosening, so the requirement for improvement is immediate and is of significant social benefit.

Composite to metal joining
Composite materials are increasingly being deployed into applications where previously metals were the predominant choice of material. Carbon fibre composite materials account for some 50% of the mass of Boeing’s 787 Dreamliner, for example, and this is a major factor in the claimed 20% improvement in fuel efficiency. Glass fibre composite is being increasingly deployed in ship superstructures and for internal panels – producing a lighter weight structure which improves fuel efficiency, payload and, above the waterline, reduces the tendency to roll.

It is frequently a design requirement to join composite to metal. The production of surface features that allow a metal component to bond to many layers of laminate can potentially improve the bond strength. This technique is currently being assessed for a number of different products.

Heat exchangers
Thermal management of microprocessors and associated systems has become particularly challenging both at chip level and at the system level in data centres. The density of semiconductor devices has continued to increase, as is evident within desktop computers, where the last few years has seen more elaborate solutions to air cooling, and even the introduction of liquid spray cooled devices. A variety of small features produced with power beams, that provide beneficial fluid flow and improved heat transfer are being investigated.

Ultra-thick coatings
Within work at TWI that is focused on the manufacture of the plasma facing components of the ITER fusion vessel, the steel substrate has been treated with electron beam Surfi-Sculpt prior to applying an ultra-thick (e.g. 3mm) tungsten layer using vacuum plasma spray. The process has been shown to be beneficial in preventing ‘peeling’ of the layer,

a phenomenon that normally occurs due to the high residual stress built up as a result of the mismatch in expansion coefficient. It is anticipated that this process may have many other applications where it is desirable to apply thick coatings.

Some of these and other potential applications of the Surfi-Sculpt power beam process have already been implemented on a commercial basis using electron beams, but at the moment no applications involving laser beams have reached production.

Conclusions
The objective of this work was to demonstrate the Surfi-Sculpt technique using laser beams. From the results presented it would appear that similar mechanisms and physical processes are involved in the generation of these features, whether laser beams or electron beams are being used. With laser beams, the process lends itself to the use of high brightness fibre delivered laser beams and galvanometer driven scanning systems, although it is possible that some shapes might be produced by using a fixed beam and manipulating the workpiece. The main compromise for the latter will be speed of movement and acceleration available. As well as producing Surfi-Sculpt features in metal, this work has shown that it is also possible to produce similar features in plastic material, notwithstanding the large difference in viscosity of the molten material. When processing titanium alloy, a very significant influence of the atmosphere in the region of the process was noted.

Acknowledgements
This work was funded by the industrial members of TWI, as part of its Core Research Programme. Colleagues at IPG Photonics, SPI Lasers and Trumpf, should also be thanked for use of their equipment in these trials. Lien Nguyen is also thanked for her contribution to the experimental work reported here.

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See Observations p49

Continued from p 55

Micro-Nano processing workshop report

Clive Grafton-Reed of Rolls-Royce provided a brief insight into their laser manufacturing technologies. Applications included laser drilling, cutting of combustors and turbines as well as welding of combustors and fans. Manufacture of compressors includes laser peening of fan blades; lasers are also used for additive manufacture, local heat treatment and cladding, and for cleaning surfaces before repair. Looking to the future, Clive highlighted laser beam pulse shaping and the tuning of energy distribution during the manufacturing process (e.g. during drilling, to reduce recast, micro-cracking, oxide and HAZ and thereby to give better repeatability and hole quality). Rolls-Royce are looking to broaden their use of lasers in production and are keen to acquire more wavelengths and different powers including ultra-short pulse length lasers for “cold” processing at economic rates. Fibre lasers are particularly interesting for welding and when the price matures Clive wants to see them on standard platforms.

Sascha Weiler of Trumpf (DE) discussed industrial micro-machining with high average power picosecond lasers and the ability of these sources to achieve cool or even cold processing and showed impressive results with the new Trumpf TruMicro series of high average power picosecond lasers working at near-IR, green and UV wavelengths with good beam quality (M^2<1.3). More on this laser and its applications can be found in an article in this issue, p 41.

Roy McBride of PowerPhotonic spoke about the production of freeform refractive micro-optics by direct laser writing. PowerPhotonic custom micro-optics fabrication is produced on a fused silica substrate using a direct write technique (thereby avoiding tooling costs) and subsequent laser polishing. As a practical example, he showed wavefront mapping the output of high power diode lasers at full operating power where the results were translated into the specification for a wavefront compensating micro-phase plate, producing a high quality output beam.

Heather Booth of Oerlikon reviewed laser applications in photovoltaic (PV) cell manufacture. Heather described the market position, the forecast of technology adoption and the need for capital expenditure per Watt of power to be reduced in order for lasers to be competitive. Drivers for the adoption of new energy sources include the rising cost of energy and environmental concerns. Market demand has produced an exponential growth in PV manufacture and the forecast is for it to continue. Oerlikon Solar are working towards the goal of achieving grid parity by innovating in three areas: (i) Reducing the $/W to make laser technology more competitive; (ii) improving module efficiency; and (iii) improving the economics of scale by using larger fabs. Lasers currently find applications in many areas in the production of PV cells, including patterning, border deletion, edge isolation, ID marking, wrap-through, cutting, doping, defect repair and interconnection. However, most of these applications are only partially adopted or are used only on a pilot line.

Sohaib Khan of NWLEC described the use of CW fibre laser for the production of nanoparticles. The production rate is high and of interest for commercial production as well as for research in-house. Pulsed laser technology is used to make variable sized particles for use in many applications. Applications include: use as an energy converter in solar cells; gas or temperature sensors; solid oxide fuel cell; UV protection; waste water purification; and catalysts and catalyst supports.

AILU thanks go especially to Martin Sharp (NWLEC) who provided all the local organisation for the event and Malcolm Gower who provided valuable advice on the programme structure.

OBSERVATIONS

Short comments on papers in this issue

Fine laser cutting

Paul Harrison

This is an excellent article that covers all the important aspects of fine laser cutting. I strongly agree with the author that fine laser cutting is a distinct area where the laser is one of the best tools of choice. I would perhaps go further and suggest that this area is more significant than micromachining in terms of revenues generated in the UK and worldwide. It just doesn't quite get the media exposure that micro and nano currently does, so well done for highlighting this key area!

Although not easy to confirm, I would suggest that the Nd:YAG laser does most of the fine laser work. Its wavelength, power, interaction with metals, focusability and general availability all contributing in part to its popularity.

What developments lie ahead for the fine laser cutting job shops? Possibilities include: cutting exotic materials; drilling of fine holes; reworking bodged traditional cutting; and perhaps miniature marking. We look forward to finding out what the future has in store for us …

Simon Lau Lasers Are Us

Not so long ago the term 'laser cutting' could safely cover the majority of the work taking place in machining/cutting of metals, plastics and other common materials. However, the rapid rise in true micro-machining (sub-millimetre features or micron precision) in the past 3-5 years has meant that this area now deserves a separate treatment covering it's specific properties and benefits. This article introduces 'fine laser cutting' and links it well to related types of laser processing. As Paul points out fine laser cutting is a very diverse field but relatively immature as compared to macro-cutting sectors. Fine laser cutting is becoming increasing diverse but, at the same time, an increasing number of different industrial sectors are adopting it in high volume manufacturing. Fine laser cutting is therefore set to become a dominant sector in the next decade as compared to any of the more-established laser processing sectors. It serves the user community well to be reminded of the distinctiveness of fine laser cutting and the emerging benefits which this area can bring to the industrial landscape.

Nadeem Rizvi
Laser Micromachining Limited

Laser cutting: some surprises

Bill O'Neill

Bill has produced a very useful article which separates the wood from the trees as far as the up and coming developments in laser cutting are concerned - it looks like fibre or disc lasers will be joining the CO_2 machines on the jobshop floor before long.

Where can I buy one of those radial polarizers?

John Powell Laser Expertise

The title of this article says it all. The research in laser cutting is experiencing a renaissance coinciding with the developments in high power fibre and disc lasers. This has been seen at conferences in the last few years where the number of research papers has been steadily increasing. Bill O'Neill, a well known researcher in the laser cutting area, highlights a number of papers on laser cutting from the recent laser conference in Stuttgart in March 2008. It is now clear from data presented from a number of research labs that the 1 micron lasers significantly outperform the 10 micron laser in terms of cutting speed when cutting steels and aluminium up to about 5 mm. The cut quality however is still better with the CO_2 laser believed to be due predominantly to the greater absorption of the 1 micron radiation higher up the cut compared to that with the 10 micron radiation and increased melting capacity and melt ejection with the 10 micron radiation as discussed by Eckhard Beyer and Gerdard Hammann.

O'Neill finished the article with the work on high speed remote cutting by Beyer and radial polarization cutting by Graf and Hammann which certainly looks very impressive and readily applicable to the industrial cutting base.

Overall, I found the article informative and although there is more research to be done to increase our understanding of the processes and mechanisms involved at the end of the day I feel it is not going to be the 1 micron versus 10 microns but the disc laser versus fibre laser for industrial laser cutting.

Milan Brandt
Swinburne University of Technology
Australia

Micro-cladding with a fibre laser

Torden Jambor and Konrad Wissenbach

The performance of the system with fine powders, so difficult to handle, is impressive. In particular, adapting the feeding and focusing to accommodate the powders appears effective. I wondered about the availability and cost of the build materials but a UK supplier (Osprey) reassured me that powders in the < 20 μm range are readily available and, due to their use in metal injection, are no more costly than larger cladding powders.

The applications described are good examples of how this micro deposition can be used. They illustrate the flexibility of the blown powder deposition process across different scales and there are also many other potential uses. I think this leaves no doubt that micro-deposition in one form or another will become established. Currently, the fibre laser is the natural choice for this process.

Any user considering applications in fields such as radio plaque markers and electrical circuits should also consider the commercially available Optomec M3D technology (http://www.optomec.com/site/m3d_home), capable of feature sizes as small as 10 um but with different material capabilities to the system described in the article.

Andrew Pinkerton
The University of Manchester

This is a very interesting article and illustrates the potential of high brightness lasers. I think in the additive manufacture field the real advantage of laser deposition lies in the ability to have very high levels of control as exemplified by the results shown in the article.

There is a debate in the additive manufacture field about the relative merits of powder or wire based deposition. The authors state that the equivalent wire based system is manual and relies on the skill of the operator for the success of the process. In principle wire could be fed automatically but the difficulty is in obtaining co-axial feed. This leads to difficulty with the orientation and alignment of the wire based system. This problem becomes more significant as the size is scaled down. The issues with powders are the relatively low efficiency and handling of the powder, especially when the particle size becomes small as in this case. Other concerns are the surface finish and the degree of consolidation, neither of which are mentioned in the article. I think on balance though that at this scale powders are the preferred option.

Several applications are mentioned in the article and I think there are probably many more. Therefore I am very pleased to see this kind of excellent work being carried out.

Stewart Williams Cranfield University

The topic of microcladding using a laser beam seems to be a very fruitful current line of development, sitting nicely at the interface point of the technologies of high brightness laser processing and microfabrication. The 100μm structural features that have been created by the Fraunhofer ILT group represent the state of the art in this field and are certainly well within the feature sizes accessible by thick film electronics manufacturing processes. The group have provided an interesting array of application examples, notable for the use of dissimilar materials to provide functionality.

The use of laser cladding at the sub-millimetric scale is part of a global movement to take what Terry Wohlers refers to as "additive fabrication" into systems engineering. I would include microfluidics here as well as electronic functionality. This is reflected in the portfolio of projects receiving UK Technology Strategy Board funding under the Direct Writing call of a couple of years ago, and the current European Commission competition for large projects using high brightness lasers within its nanosciences, nanotechnologies, materials & new production technologies (NMP) priority.

Neil Calder
Engineered Capabilities Limited

It's interesting to see that Fraunhofer ILT are now working on perfecting the art of laser micro cladding. In my view the market for this type of work can only increase in the future and it looks like ILT have already identified some interesting potential markets.

Some work will have to be done with the powder delivery systems in order to match the powder focus to the small focus spot of the laser. If this can be achieved then the process could be made very efficient with little waste powder. This would lead to significant cost savings when working with high value precious metals (e.g. silver switch contacts) as mentioned in the article.

I think the development of a very compact cladding head for this sort of work would be beneficial so that access is not restricted on small parts. With the addition of a small precision robot to manipulate the head it could prove to be a very flexible process.

John Cocker Laser Trader

This article covers all the main points that used to be a challenge in macro laser cladding but which are now quite routine. Micro laser cladding is new and it goes hand-in-hand with developments in nozzle design, hopper design (powder flow) and powder technology. Our colleagues in the ILT appear to have made advances in all three areas and are to be congratulated for their efforts.

Micro-cladding opens up many new applications, and to have arrived at a cladding nozzle that gives homogeneous wall widths of less than 100 μm is quite an achievement in the 10 years or so since the first efforts were made to scale down in size.

Laser cladding has until now been the main stay of the aerospace, mining, automotive and general heavy industry. With micro-cladding it might be possible, for example, to address challenges in the medical sector, such as depositing markers on stents, if this can be done without distorting the stent shape.

A micro cladding system is still a considerable investment, but with the advent of the fibre laser and further development of micro laser cladding nozzles, cladding systems may become affordable desk top devices that many precision engineering repair shops could use.

Leo Sexton Laser Age

Picosecond lasers and their industrial applications

Gerry Jones

The article by Gerry Jones on Picosecond Lasers and their Industrial Applications presents an overview of the many exciting developments that are now possible with laser sources such as the TruMicro 5050 thin disk laser.

In recent years the emergence of solid state laser sources based on thin disk and fibre configurations have disrupted the traditional markets based on cylindrical rod or slab geometries. The ability to provide a repetitively pulsed beam with 50 Watts of average power, operating at repetition rate of between 200 to 500 kHz, where pulse durations are less than 10 picoseconds have the potential to enable many new applications in laser fabrication at the micro-scale, as described in the article.

The author correctly identifies the pulse duration as being a most significant attribute of the laser source. In metals and semiconductors, where the energy of the photon is greater than the electronic band gap, an ultra short pulse of laser energy is absorbed by electrons in the material. During this process the material can be described by two temperatures, the temperature of the hot electronic system and the temperature of the atoms or lattice which remains cold. It is only on timescales of picoseconds when the temperature difference between the electrons and lattice equilibrates again. In simple terms when this occurs, the atoms in the lattice melt, are vaporised and ejected from the material. If the density of the ejected material, which is often highly ionised, is sufficiently high a plasma is formed above the surface of the material and this also can interact with the material and impact the quality of the laser machined feature. When one uses a long picosecond or a nanosecond laser pulse the laser energy is still being delivered to the material when the plasma and molten zone is established. In such cases the plasma strongly absorbs the laser energy; the plasma heats and expands rapidly delivering an additional thermal and mechanical impulse to the material. Therefore the advantage offered by femtosecond and short picosecond laser pulses is that the energy is delivered to, and absorbed by, the material prior to any change in the lattice temperature and the formation of the plasma.

It is clear therefore that the characteristic time with which the electrons couple to the lattice, known as the electron phonon coupling time, is most important. While the author indicates this is of the order picoseconds, its precise value depends on the electronic structure of the metal. For noble metals, such as gold and silver the electron phonon coupling time is expected to be long ~ 20 picoseconds, and in many respects for these materials a picosecond laser source will offer many similar benefits to those offered by femtosecond sources. For transition materials the electron - phonon coupling time is somewhat shorter, of the order of single digit picoseconds (3 – 8 ps). Therefore for transition metals, the actual duration of the picosecond pulse will be very important in determining the character of the ablation process. Preliminary results on the Trumicro 5050 laser suggest that it is indeed capable of demonstrating many of the benefits of femtosecond processing on these materials also. For other metals such as aluminium, the electron –phonon coupling time is shorter again, ~ 1 – 1.5 picoseconds, and here laser sources with long femtosecond duration may still offer advantages over the picosecond source.

The high repetition rate of the picosecond laser is another significant advantage over femtosecond sources. In many industrial applications, repetition rate and average power are directly correlated with throughput. The ability to deliver pulses at rates up to 500 kHz, is a very significant development for the picosecond laser source described. Moreover the ability of the laser source to provide a reconfigurable stable pulse train is also highly enabling at such repetition rates. As with many high repetition rate laser sources now emerging on the market, the delivery of the laser energy is no longer the limitation for process speed; increasingly, attention now has to focus on how best to use the available energy using novel beam delivery and novel techniques to assist in the transport the laser-generated debris from the laser material interaction zone. This is particularly relevant for machining features with high aspect ratios.

There are many other aspects to be considered when choosing between picosecond and femtosecond laser sources. More rigorous analysis typically includes attempts to describe the precise ejection of material using a comprehensive thermo-mechanical description of actual ablation mechanism. This is probably most relevant to the synthesis of nanoparticles and to the formation of thin films by laser ablation.

Also variations in the nonlinear absorption mechanisms, particularly in dielectrics, can still result in important differences.

It is clear that the thin-disk picosecond lasers and short pulse fibre laser sources, offer many new opportunities and exciting areas for investigation.

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

The article by Gerry Jones extols the muti-material and cross-applicability of the Trumpf picosecond laser source and as such gives a very concise and accurate overview of the industrial (mostly semiconductor) applications suitable for these lasers. Although the article gives a good description of the various markets, it fails to explain why this laser is better than the existing technologies, DRIE or mechanical saw, and would be worth the capital investment by ourselves or our customers.

Many applications in both the medical and semiconductor sector cross my desk, and often the laser is the most efficient process. However, when you source the laser you find that it is not cost efficient. More often than not it is a picosecond laser, with a 200k Euro price tag, which puts the customer off. Newer companies such as Fianium seem to be taking this on board and are driving picosecond laser costs down; however there is still a fair way to go. As for the cost effectiveness of the Trumpf laser, I cannot comment, as the unit cost was not mentioned by the author.

The present article discusses the benefit of high pulse energy, low rep rate over low pulse energy high rep rate picosecond systems. This is an area where I would like the laser manufacturer to give some evidence for their claims. My own experience is that it depends on the application and the material.

David Gillen
Blueacre Technology Limited

(See also David Gillen's 'Opinion' piece on page 27 - Ed)

This is a welcome overview of microprocessing with picosecond lasers. I believe that ps lasers will be an important part of laser micromachining in years to come and will gradually displace DPSS nanosecond lasers in some applications. From the work that we have done with ps lasers it is clear that for certain applications ps lasers can produce a superior quality feature than ns lasers. This especially true when pulse energy requirements are modest (<0.2mJ). In applications where throughput is directly driven by pulse frequency, eg many patterning applications, then the high prf (100 kHz - 20MHz) can give the ps laser a distinct advantage over ns lasers. Althought the article describes a number of applications, it is lacking in the details of process speed and achieved tolerances to effectively put the case for using ps lasers in these applications. The case against the ps laser is that their cost is much higher than ns lasers and their reliability in the past has not been as good as ns lasers. In the last year we have seen more lasers manufacturers enter the ps market, including some of the larger suppliers. From a user point of view we hope that this will drive down the cost and improve reliability of these devices to enable more users to benefit from their processing capability.

Martyn Knowles
Oxford Lasers

Soon after the invention of the laser focused high intensity short pulses were known to be capable of removing material with minimal heat affected zone. Up to the early 1980's most experimental studies in this area were targeted towards studying laser damage effects of optical materials with the pulsed lasers then widely available having durations longer than about 10 psec. Perhaps fortuitously the nature of the laser-material interaction for such pulses places it a thermal diffusion regime whereby the characteristic behaviour of the threshold energy fluence for damage having a square root dependence on pulse duration was soon well understood. During the 1980's true ablative micro-structuring of materials was developed using predominantly nanosecond pulsed excimer lasers at deep ultraviolet wavelengths for which most materials are highly absorbing. When in the early 1990's longer wavelength ultrafast lasers with pulse durations of ≤ 100fsec became available, first demonstrations were made of cold ablative machining of materials in a regime where during the pulse little material or energy is transported away from the irradiated site by vaporization, shock or thermal conduction. For high intensity pulses of such short durations free electrons are readily produced by multiphoton absorption and ionization. Further accelerated by inverse bremstrahlung absorption, these electrons in collisions with neighboring atoms lead to cascade ionization on a time scale much faster than heat is transferred to the surrounding lattice. The high plasma temperatures obtained with such short high intensity pulses ensures vaporised material is removed from the kerf without re-deposition. Although concurrent demonstrations showed such clean micromachining can be achieved with pulses 10-100 times longer, it was not until very recently that robust pulsed solid state lasers producing high average powers in the picosecond regime become available commercially. Previous commercial picosecond lasers were limited only to R&D mode-locked versions of low power lasers such as Ar ion, dye or He-Ne. Today researchers have demonstrated most materials can be micro-machined with picosecond pulses to produce as good a quality a result as can be obtained with ultrafast pulses. Since such lasers can produce average powers more than ten times higher than ultrafast lasers, they are potentially attractive for many industrial applications where speed, parts throughput and unit processing costs are key issues - areas where their ultrafast cousins frequently fall well short on when undergoing industrial evaluation trials.

This excellent article by Gerry Jones illustrates well both the rapid pace that has occurred recently in engineering picosecond laser sources around the 50 W average power level as well as demonstrations of their capability for micromachining materials in key industrial areas such as back end microelectronics applications in microvia hole drilling, wafer and package dicing, thin film scribing of photovoltaic materials and fuel injector drilling – all applications for which nanosecond lasers are currently used with varying degrees of success. It certainly is interesting to observe how seriously industrial laser machine tool leaders such as Trumpf are taking this technology in developing products to suit a wide range of applications in manufacturing. Without suitable laser sources tailored to best match a process, new applications for laser processing are at best slow and at worst impossible to develop. On the other hand, laser manufacturers are understandably reticent to invest in the development of new classes of lasers without a 'killer application' in the bag. That said, one must always be mindful that in most industrial applications it is not the quality of result which is the most relevant yardstick that determines if a particular technology is adopted for manufacturing. Process speed, cost, flexibility and reliability are often more important to the production engineer. Thus it will be very interesting to see over the next few years how many new industrial markets are opened up by picosecond lasers and the impact they have in taking market share away from applications which currently use nanosecond lasers.

Malcolm Gower
Nanophoton Technologies

Two photon polymerisation: technique and system

S Passenger et al

To be able to initiate polymerisation within a photosensitive material opens up new potential for this technique. The 100 nm resolution sounds impressive and the recent speed improvements represent a great advance. However, I am still not clear about how long it takes to create a 3-D object of any size; consequently I find it hard to assess whether or not the process will be viable for creating 3-D objects, except in niche areas. A time to create a cubic millimetre, with a given resolution, would be very useful.

The creation of microneedles seems a realistic proposal as a functional photosensitive material is available and appears to work quite nicely. Again, whether these can be produced quickly enough to be viable I do not know. The microneedle structures look ideal, and although there could be some questions about their structural integrity, I am sure this can be solved if it has not already been.

In summary, this is an interesting area that could become very useful in the future and credit must be given to the authors for what must have been a long road to get this far. The creation of these objects is remarkable and I wait with interest to see their future evolution.

Neil Sykes Xtreme Laser Facility
Cardiff University

The writers present some very impressive results from their work on two-photon polymerisation for 3-D structuring. Their work has addressed one of the main drawbacks of engineering on such a high-precision scale, that of writing speed. With speeds up to 30 mm/s, the process is stepping up beyond mere research or demonstration, to the needs of manufacturing industry. It is to be expected that the parallel advances in short-pulse sources, particularly the development of high-average power sources will complement the system described here and open up the possibility of further significant throughput gains.

One area which still requires attention, especially when applications such as stenting or biomedical implants is discussed, is biocompatibility. The range of materials available for use with the system is somewhat limited, and work on the expansion in this range may prove advantageous in opening exciting new applications and gaining greater penetration for the technology onto the factory floor.

Tony Flaherty
National Centre for Laser Applications, NUI, Galway

A new method of laser beam induced surface modification

Paul Hilton and Ian Jones

"Have you seen this?" says Paul Hilton to me at some meeting whereupon he produces a small slab of Ti that looked as though it was a work of art with a diamond studded surface. This was my introduction to Surfi-Sculp®. It was so refreshing to be faced with something utterly novel, pleasing to look at and currently looking for an application.

A surface covered with small studs sounds ideal for industrial walkways, but then one realises that the structure has pits as well as peaks and would hence corrode in a wonderful way if exposed to the rain. So if corrosion is a problem how about batteries with structured surfaces to the electrodes? One's imagination is fired up by the simplicity and novelty of the process. This article contains several much better and sounder based ideas than those suggested above.

One wonders what other shapes than studs can be made by varying the swipe pattern. In essence the process produces a small lump by moving the melt to the start of a surface melt run. This can be generated by a short traverse of the focused laser beam. These lumps add together to make a combined shape. Could a different shape ruck be generated by twin beam work, perhaps working in a fast flowing gas? There are so many possibilities for this exciting process but one thing I would count on is that the TWI, amongst others, will be exploring them.

William Steen

The process outlined is very interesting, as it takes an existing process proven with electron beam welding (which I first saw used in the mid 1990's to resolve an issue with the bonding of the metal bonnet hinge and latch brackets to the sheet Moulding compound bonnet panel on a US-built super-car). Using lasers to allow the process to be carried out in a normal atmosphere will greatly increase the potential working envelope and reduce manufacturing costs. From my understanding of the process it would appear possible to integrate the process into a laser remote welding facility fairly easily.

The key benefit of the process is that it produces a reasonably robust cone of repeatable height. This is very important when looking to work with adhesives, as most need to bond within a range given by both a maximum and minimum gap between the items being bonded to ensure a consistent joint performance.

One of the key problems when bonding two surfaces together is how to prevent them being too close together. Currently, this issue is overcome by including glass beads of a diameter equivalent to the minimum allowable gap in the adhesive mix, thereby physically preventing the two bonded parts getting too close together. However, the inclusion of the glass beads in the adhesive leads to problems with excessive wear in the adhesive pumping, dosing and applicator systems.

This optimum gap range for the adhesive to work properly is used in automotive assembly to allow the adhesive to take up tolerances within the assembly and thereby ensure a constant outer surface condition (i.e. the Aston Martin DB9 bodyside to chassis tub joints).

In Aerospace applications the maximum bond thickness is very small (typically between 0.2 and 0.7 mm), so the need for a good quality consistent height cone that will not break off the base material is very important.

One concern I have is that, when bonding a metal part to a CFRP part, or to bond parts made from dissimilar metals, the cone could be a source of contact between the two parts, giving a clear corrosion and/or lightning strike path. A possible solution to this would be to coat the bond side of the CFRP part with a thin layer of glass fibre to act as an insulator between the two parts, or to use an adhesive gasket, a technology that is just starting to be applied in aerospace applications.

The article correctly identifies potential applications in both aerospace and ship (yacht?) building. In the automotive sector there is also EU legislation soon to come into force concerning the roll over of tall vehicles and the need to lower the centre of gravity of most 4x4's and vans. This will be achieved by changing the material of the roof panels of these type of vehicles from steel to aluminium, CFRP or SMC, and these will need to be bonded to the (typically) steel vehicle bodysides, requiring that a suitable adhesive bond gap is maintained, to ensure both the correct performance of the crash-critical roof to bodyside joint and that the joint remains water leak and corrosion free.

Stephen Ainsworth
SJ Ainsworth Concultancy Ltd

Continued from p 54

Medical laser workshop report

After lunch Sean Burke from Enterprise Ireland illustrated the opportunities and possibilities for funding in Framework 7 programme with particular focus on the opportunities for SMEs.

In the second keynote presentation of the day, Jens Gedvicke of the Fraunhofer ILT Aachen gave a presentation on novel laser processes for packaging and adding functionality to medical components. As examples of added surface functionality in medical products he addressed: self cleaning surfaces, improved fluid control; non-adhesive surfaces; and surfaces for controlling cell growth. He also described the use of fibre lasers for micro-welding metals (see figure 3), plastics (the TWIST technique - see Issue 49, p 32) and joining dissimilar metals.

The Innovations Session of short presentations comprised presentations from: Alan Ferguson of Oxford Lasers (GB) describing ultrafast laser processes for medical device manufacturing; Jonathan Magee of Rofin-Baasel described case studies of the use of lasers in cutting, welding and marking for medical instrumentation and implants; Jüergen Bock of Precitec (GER) described the development of laser cutting heads at Precitec; Birk Plöennigs from Jenoptik UK described the laser welding of plastics and its application in the medical sector; and Louise Partridge of SPI Lasers (GB) talked about medical device and instrument micro welding and cutting with fibre lasers.

At the end of the day Mike Green, Anna O'Neil and Leo Sexton (LaserAge) gave presentations about AILU, the Medical Group and opportunities for an association like AILU in Ireland, respectively.

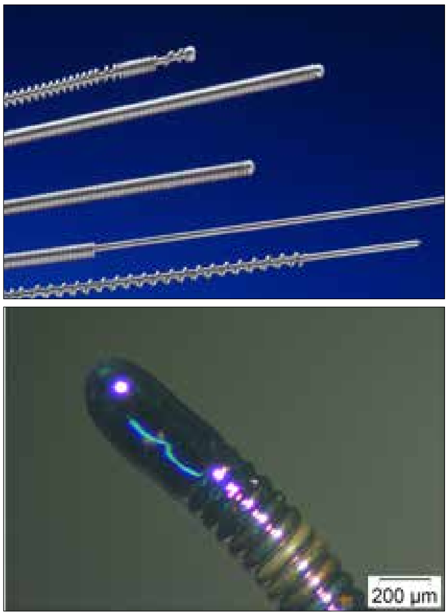

Figure 3: Laser beam welding of neurovascular coils using a double pulse from a diode laser. (Courtesy Fraunhofer ILT)

FREE

If you have any interest in this report you should be a member of AILU's Medical Special Interest Group

To join simply email anna@ailu.org.uk with your name and the message 'enrol me in the Medical SIG'

Opportunities for laser micromachining: developments and applications in the medical sector

22 May 2008 - National Maritime College of Ireland, Cork

AILU's Medical Group held it's first event of 2008 in Ireland, a country where medical device manufacture is thriving. Large multinational companies in the medical sector – particularly those from the USA – have their European centres in Ireland. (See Leo Sexton's article on business developments in Ireland, Issue 49, p25)

The event "Opportunities for laser micromachining: developments and applications in the medical sector" was held at the National Maritime College of Ireland in Cork and was organised and managed in conjunction with LaserAge, based near Cork and the CAMMS, the Centre for Advanced Manufacturing and Management Systems, at the Cork Institute of Technology. Over sixty delegates attended the event, which was chaired by Pat Forristal, Vice President of International Advanced Operations from Stryker Orthopaedics (Cork) and Chairman of the Irish Medical Devices Association

Andreas Ostendorf, Director of LZH Germany, gave the keynote presentation in the morning on the generation of biocompatible 2-D and 3-D structures for medical implants by 2-photon polymerisation using femtosecond lasers; for example, to produce structures that simulate bone. (See article on p 44 of this issue)

Frank White from Stryker Instruments described how their site in Cork, the key Stryker site for tissue cutting technologies, uses laser cutting, marking and welding to manufacture medical instruments. He illustrated the flexibility of lasers for batch manufacture of bespoke blade assemblies (see example in figure 1).

Figure 1: Selection of surgical tools (Courtesy Stryker)

Nadeem Rizvi of Laser Micromachining Limited (GB) described the wide range of different lasers they use for prototyping and low volume medical device manufacture.

David Gillen of Blueacre Technology (IRE) spoke about 'stop on layer' laser processing, which centred on the control of ablative material removal and its importance in medical device manufacture. The technique can be used for thin layer metal processing, the stripping of polymer layers and in the production of multilayer devices. He illustrated how it was possible to prevent damage of underlying material or (when hole drilling in tubes) back surface damage, and showed laser drilling of 1500 holes per second with accurate control of ablation depth (see figure 2).

Dermot Brabazon of Dublin City University gave a wide ranging presentation on biomedical applications of laser plasmas, touching on a wide range of laser materials processes: cutting, drilling, welding; surface treatments; laser cladding and pulsed laser deposition; and rapid prototyping. He went on to discuss developments in laser use in plastic and cosmetic surgery, ophthalmology, selective laser trabeculoplasty, micro and nano surgery; diagnostics – imaging and spectroscopy; and micro nano fabrication. Throughout he emphasised the need for parametric mapping of the process and accurate measurement and control of laser electronic control of power density.

Martin Sharp of Lairdside Laser Engineering Centre (GB) described the recent work of the North West Laser Engineering Consortium of the universities of Liverpool and Manchester in micro fabrication. Areas addressed included: (i) femtosecond laser machining of micro and nano surfaces, the production of micro-channels, micro-texturing and activating surfaces; (ii) the

Workshop speakers: (l to r) Leo Sexton (LaserAge), Mike Green (AILU), David Gillen (Blueacre Technology), Pat Forristal (Stryker Orthopaedics), Nadeem Rizvi (Laser Micromachining), Andreas Ostendorf (LZH), Louise Partridge (SPI), Jens Gedvicke (Fraunhofer ILT), Jürgen Bock (Precitec), Martin Sharp (LLEC), Alan Ferguson (Oxford Lasers), Birk Plönnigs (Jenoptik), Frank White (Stryker Instruments), Dermot Brabazon (Dublin City University), Anna O'Neil (AILU) and Tony Flaharty (NCLA, Galway)

use of CW fibre laser sources for the production of sub-micron powders; (iii) laser enhanced MoCVD, CVD & Sol-Gel Coatings; and (iv) microbuilding and microdeposition using optical tweezers technology.

Tony Flaherty from NCLA Galway spoke of "Light Factory 2020" an initiative to bring photonics into Irish manufacturing. The programme integrates initiatives in EU policy, collaborative research, networking and training, with an expansion of LightHouse, a combined activity of laser and photonics research groups within the University of Galway. He pointed out and illustrated how the drivers for economic transformation in Europe from an industrial to a knowledge-based economy are as strong in Ireland as in other EU countries.

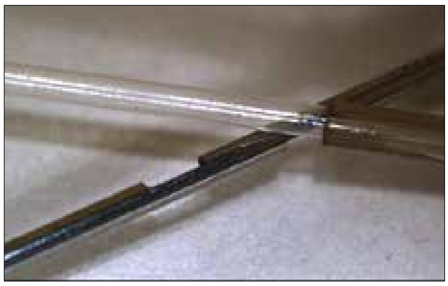

Figure 2: 'Stop on layer' stripping of 0.1 mm polymer lining from a PTFE tube of wall thickness 0.025 mm without residual damage. (Courtesy Blueacre Technology)

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Industrial and research opportunities in laser micro and nano processing

4 and 5 June 2008 - Daresbury Laboratory, Warrington

At the beginning of June Daresbury Laboratories saw the tenth anniversary of AILU's annual micro-processing meeting. To celebrate the event, AILU joined with the North West Laser Engineering Consortium (NWLEC) to provide a two day event. Over seventy delegates, including a strong student contingent from the Universities of Liverpool and Manchester, came to network and to hear presentations from international companies and academia, This report relates only to the first day, which was largely organised by AILU.

Workshop speakers (L to r) Sohaib Khan (NWLEC); Malcolm Gower (Chair); Walter Perrie (NWLEC); Richard Murison (Pyrophotonics); Guido Hennig (MDC Max Daetwyler); Heather Booth (Oerlikon); Sasha Weiler (Trumpf); Clive Grafton-Reed (Rolls-Royce); Martin Knowles (Oxford Lasers); Roy McBride (PowerPhotonic); Nadeem Rizvi (Laser Micromachining).

Missing from the photo are Qin Hu (University of Cambridge); Mike Damzen (Midaz Laser); Zengbo Wang (NWLEC); and Mike Osborne (Optek Systems)

The workshop was chaired by Malcolm Gower, who gave a short introduction to the subject, pointing out the predicted near-term growth of laser micro-processing machines (see figure 1) and emphasising that the aggressive drive for increasing miniaturization of components will continue to push the spatial limits of manufacturing technologies into the nanometer regime.

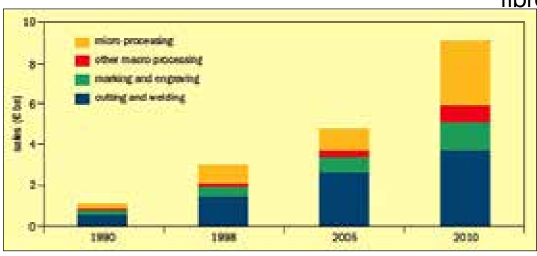
The invited speaker, Guido Hennig of MDC Max Daetwyler AG (Switzerland), described the large scale laser micro-structuring of gravure print rollers and the importance of producing the desired size and capillary action to release the optimum amount of ink without wastage. In doing so he provided an excellent example of the industrialisation of a state of the art (laser) processing.

Qin Hu from the University of Cambridge discussed the forming and production of micro and nano-scale components. The work is part of a £9 million funded 4-year Grand Challenge project to develop true-3D, multi-material and miniaturized technologies and then transfer the technology from the research base to a viable industrial process. Currently she is focused on a new 3-D manufacturing approach termed 'Laser Print Forming' that combines the merits of nano-technology and ultrafast laser machining.

Nadeem Rizvi of Laser Micromachining Limited spoke on laser-assisted manufacturing for emerging technology sectors. With a wide range of different lasers of many wavelengths from CW to ultrafast pulse duration available in-house, he described their usefulness and versatility for prototyping and low volume medical device manufacture.

Walter Perrie of NWLEC gave a presentation on high throughput parallel micromachining using a femtosecond laser. He described the possibilities of using a computer-generated hologram produced on a Spatial Light Modulator (SLM) to control beam profile and, for parallel processing, produce many lower power beams for laser machining.

Richard Murison from Pyrophotonics in Canada described the technology and micro-machining applications of their fibre laser, which offers complete pulse shape control. He explained how this allows full variability parameters to establish the optimum conditions for each material/process. The source would initially be of particular interest to research groups investigating optimal parameters for different applications.



Annual laser systems sales worldwide. The prediction in 2007 is that by 2010 laser micro-processing system sales will reach $4.7B and will become the largest of all system types (Courtesy of Optech Consulting)

Mike Damzen of Midaz Laser discussed their micro-slab DPSS lasers, which offer high power and pulse rates for high speed micromachining. The Midaz DPSS laser has a side-pumped microslab architecture that allows very high average power scaling (to approximately 100 W) with excellent fundamental Gaussian beam quality; the laser is compact and has high gain and efficiency. Pulse rates in excess of 1MHz are available, with peak powers of about 1MW. A conversion efficiency of almost 60% is achievable for generation of a variety of wavelengths in the visible and UV.

Zengbo Wang from NWLEC described the use of near field imaging for sub-wavelength processing. Near-field systems involve interference of evanescent waves. Applications include nano-patterning using contacting particle lens arrays (CPLA); illustrations included arbitrary shapes on a nano-scale using oblique angles of incidence. He claimed that the CPLA technique competes favourably with microlens array systems currently in use. Potential applications include large area surface roughening, micro and nano fabrication of periodic arrays and for data storage.

Martyn Knowles from Oxford Lasers gave a review of micromachining of glass and other transparent materials with nano, pico and femtosecond lasers. Photonics applications rely heavily on transparent media (in particular glass, fused silica, sapphire, PMMA and polycarbonate), making laser processing of transparent media on the milli, micro and nano-scale increasingly important. Restricting his talk to UV and ultrafast laser processing he discussed the properties of UV laser processing and the interaction of ultrafast laser beams with the materials they process.

Mike Osborne of OpTek Systems discussed CO_2 laser processing of micro-optics. OpTek produce many systems and automate the process to ensure good yield and reproducibility. He provided examples to show how CO_2 laser processing of quartz optical components can be rapid, flexible, reproducible and accurate, including the production of geometries that are difficult or impossible to achieve by other means. Laser cleaving is a fast accurate process, including the cleaving of photonic crystal fibre.

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Lunchtime virtual lectures

I hope you took a look at the events page on the AILU web site recently otherwise this note may have reached you too late for the live performance but it is still available to view later.

At 1pm on Friday 7 July AILU is providing our first lunchtime 'webinar': it can only be viewed on-line. The presentation "Laser processing of micro-optics and interconnects" will be given by Mike Osborne from OpTek System and will last 20 - 25 minutes, followed by questions and answers. You will see the PowerPoint slides and hear Mike's voice.

There are, however, some hoops to jump through first:

1. The webinar is being hosted in the members area of the Photonics KTN web site (http://photonicsktn.com). Most AILU members are already signed up and you should have your password, but if not you will need to join (which is free) which you can do on the site.
2. You need to download the Interwise conferencing software (which is free), but for this you will need a Windows-based PC running Internet Explorer v5.5 or greater.
3. If you want to participate in the live event you need to register beforehand; this is to enable you to ask questions afterwards.
4. To enjoy the webinar you will need a headset or microphone and speakers, and a broadband internet connection.

Full information and guidance see: http://www.ailu.org.uk/pktn_lectures_meetingplace

If you miss the seminar you will be able view it later (slides and audio including additional videos) on either the AILU or PKTN websites - the only thing you will miss is the opportunity to take part in the questions and answers.

Mike's seminar is part of the "Photonics Lunchtime lecture series", organised by the Photonics KTN, of which AILU is a member. The main attractions of these events is that they involve no travel, and they are able to reach a broad, international audience.

If you have ideas for future topics or would like to discuss the possibility of making a presentation, please contact Anna O'Neil at anna@ailu.org.uk.

AILU's forthcoming Medical Group events

Lasers in medicine and biophotonics
Part of the Photon 08 conference at Heriot-Watt University, Edinburgh from 26 - 29 August 2008 is an 'Industrial Technology' seminar series. As part of this AILU's Medical Group is running a 1 day event under the chairmanship of Duncan Hand. The scope of the workshop is to address developments in lasers, beam delivery, monitoring and control, auxiliary equipment, safety and standards and their potential impact in biophotonics and medical research.

Speakers include Tom Brown (St Andrews University), Jon Parry (Heriot-Watt University) Nick Jones (Renishaw), Jonathan Leach (Glasgow University), Holger Lubatschowski (LZH, Germany), Jon Exley (Lynton Lasers) and John Colles (Denfotex)

For more details and to register for the event on go to:
http://www.photon.org.uk/

Opportunities for photonics in medical device manufacture
AILU's Medical Group is holding a half day meeting as part of the seminar series at the Photonex exhibition, on16th October at Stoneleigh Park near Coventry.

This event is free to attend and since the seminar area is in the exhibition hall delegates will be able to drop in and out on the day.

There will be two sessions: one in the morning (11:00 – 12:40) addressing lasers for medicine and biophotonics devices; and one in the afternoon (14:15 – 15:35) on innovative products that will allow suppliers to highlight new developments.

Four of the eight seminar slots are already taken so if you are interested in making a presentation then please contact Anna O'Neil at anna@ailu.org.uk.

See page 43 for a brief review of the AILU AGM (8 April 2008)

EVENTS

JULY

4 **AILU Webinar (1 PM)**
Laser processing of micro-optics and interconnects
Mike Osborne, OpTek System
http://photonicsktn.com

AUGUST

26 **PHOTON 08 (26-29)**
The largest optics conference event in the UK
Heriot-Watt Univer, Edinburgh
http://www.photon.org.uk/

27 **AILU Medical Workshop**
Lasers in medicine and biophotonics
A full day programme as part of the Photon08
http://www.photon.org.uk/

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/

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 TO FOLLOW

AILU Workshop
Laser processing of composites
Date and venue TBC

Making up a magazine

"Sales of sheet metal cutting machines make up 49% of total sales ... but it's still worth keeping an eye on the micro-processing sector for future opportunities."

As I reported at the AGM this year, the web site problems we experienced in late 2007 and the first quarter of 2008 resulted in a much poorer AILU income from advertising than had been expected. However, with the new web site up and running and a monthly e-newsletter ready to launch, we can look forward to a growth in advertising revenue this year.

This magazine contains very little advertising. It is seen by the committee as a media for impartially disseminating information rather than a source of advertising income, and this liberates me, as editor, from restrictions on what the theme will be for a particular issue, right up to a month before publication or even less! To some extent this is making the best of our over-stretched resources, and more help with the magazine would be welcome - see 'guest editor' advert on p 2.

If we based the magazine content on members' current activities then sheet metal cutting would be the dominant theme. Indeed, sales of sheet metal cutting machines make up 49% of the total world sales in laser materials processing systems, according to David Belforte who presented the statistics at a recent laser marketplace event (Photonics Cluster, 19 June). However, research in this field has been relatively quiet in recent years, so Bill O'Neill's paper in this issue highlighting some new and exciting developments is particularly welcome.

Nevertheless, most new developments in laser materials processing are at the micro level, and this is likely to remain so. Within this issue we have a number of paper on micro processing plus a front cover photo of a component with a width less than half the diameter of a hair on your head. Even so, there is plenty on milli and macro processing in this, the largest issue of TLU!

In his presentation on 19 June, Belforte noted that sales in laser micro-processing systems has risen to almost half that of laser systems for metal working: it's the biggest growth sector. So even if your current activity is laser cutting at the macro level, it's still worth keeping an eye on the fine and micro processing sectors for future opportunities.

Mike Green, Editor
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Editorial Policy

The Laser User is the house magazine of the Association of Industrial Laser Users. Its primary aim is to disseminate technical information and to present the views of its members.

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

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

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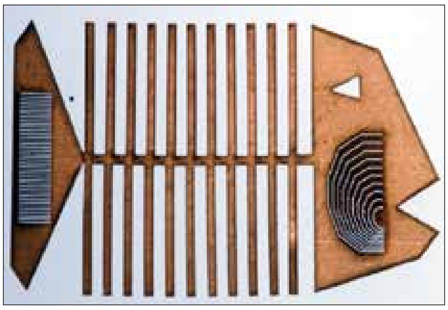

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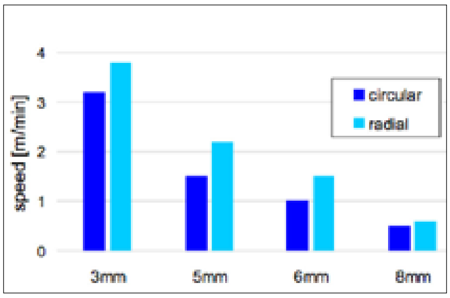

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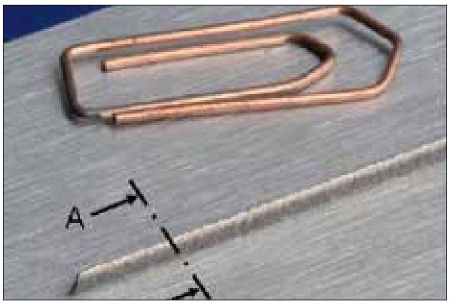

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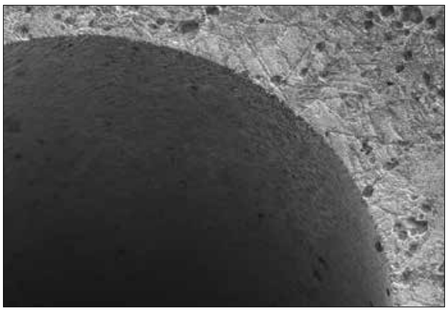

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