The Industrial
LASER USER
association of industrial AILU laser users

Issue 26 *March 2002*

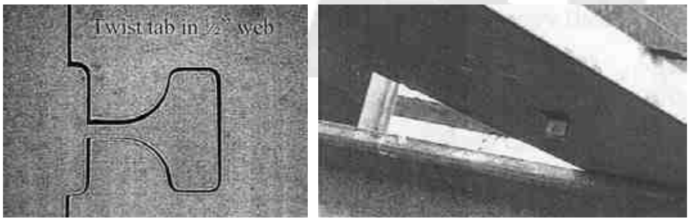
Novel and Ancient Ideas Stimulate Creativity

Creative interchange of knowledge and ideas had started even before the November 2001 meeting "Tips and Secrets of Design for Manufacture by Laser" had begun. Those who stayed in Filton the previous night enjoyed a convivial meal enlivened by discussion of their work and the processes and materials they employ. These ranged from the oldest 'blacksmith techniques' for processing bronzes and iron through to in-vacuum diffusion bonding of exotic alloys.

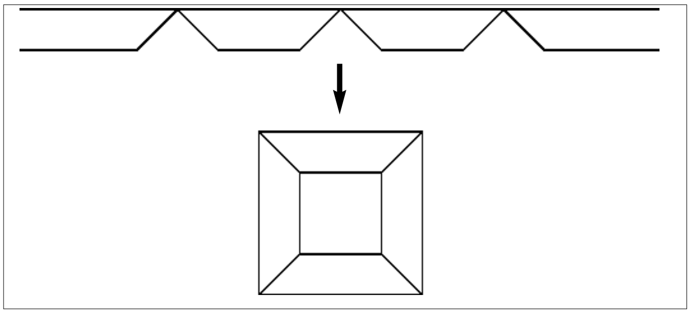
The meeting took place in the comfortable surroundings of the BAWA Centre, Bristol, where we were the guests of BAE Systems. The proceedings started with Stewart Williams' fascinating presentation of his group's work on conduction limited welding of aerospace materials using low-brightness diode lasers (See Issue 25, pp 25 – 27). This subject was later brought to life during our busy tour later in the day of the laser-related work at the nearby BAE Advanced Technology Centre.

Lino Grisoni illustrated some of the advantages of using tube as a raw material for the production of components and the benefits of using lasers to process the tubular material. He demonstrated the particular benefits of design flexibility and the opportunities tubes present both to eliminate process steps and to reduce part count through the production of more complex parts (see illustration below). See also the feature on p 14.

Two examples of simple and cost-saving tips for designing for laser cutting



An example of use of laser machined twist tabs. The above pictures, shown at a presentation by Patrick Cahill of Bender Shipbuilding, USA, at a recent Make It With Lasers meeting (TWI North East, 31 October 2001) illustrated how laser-machined twist tabs, with laser-machined slots in the mating part, can be used to hold heavy components together during welding. At Bender, this has resulted in a 50% reduction in fit-up time and elimination of the need for tack welding.



One of many examples of how laser tube cutting can bring freedom to simplify design and reduce part count. In this example, a tube with v-cuts can readily be bent into a frame, for greatly simplified welding

***Speakers at Design for Manufacture by Laser** Left to right: Bill O'Neill (University of Liverpool), Isaac Chang (University of Birmingham), Lino Grisoni (Adige Sala SpA, Italy), David Miller (Linx Xymark), Tim Weedon (Chair) and David Brown (Wave Precision, USA). Missing from the picture is Stewart Williams (BAE Advanced Technology Centre, Sowerby)*

Bill O'Neill's presentation offered a glimpse into the Caterpillar approach to design for manufacture and the opportunities that lasers offer for 'mass customisation'.

The work of the University of Birmingham's Institute of Metallurgy and Materials Science on the use of laser sintering to produce tooling rapidly was introduced by Isaac Chang. Additive processes are opening up new opportunities for the economical manufacture of complex components and there was considerable interest in the issues discussed. Rapid prototyping and tooling will be the subject of a dedicated AILU meeting in Nov/Dec 2002.

David Brown appealed to the audience to learn from history and from nature in his outline of the "The practicum of flexure design and application". (See feature on p 30). Encouraging engineers to move away from always striving for infinite stiffness, he showed how nature provides design ideas. David's exhibit of GSI Lumonics galvanometer scanning heads and some of the other exhibits, notably that of Micrometric Techniques, illustrated the point.

The theme of looking at the familiar in a new way was carried forward into David Miller's presentation of novel processes undertaken using Xymark marking lasers. These included marking glass at high temperature to yield new results and selectively perforating individual layers of a polymer laminate to ease and guide tearing.

Finally, Mike Green gave an illustrated progress report on the implementation of the AILU Virtual Laser Expert (see update on p2).

It was clear from the number of exchange visits being arranged in the coffee breaks that the trading of clever ideas will continue long after the meeting.

Tim Weedon Workshop Chairman

Emma Johnston wins Young Laser Engineer Prize for 2002

Emma Johnston

The Young Laser Engineer Prize for 2002 has been awarded to Emma Johnston for her work on Laser Scabbling at the University of Liverpool.

The laser scabbling process involves removal of surface material by a defocused laser beam. To date, it has most successfully been applied to concrete, to which average depths of removal of 15-20mm have been achieved in a single laser pass. The process is of interest to a number of industries not least as a potential decommissioning tool for the nuclear industry.

Laser scabbling was first observed as a phenomenon during work at the University of Liverpool to glaze a concrete surface using lasers. “I took this concept and developed it into a full set of process conditions for a wide range of operational requirements and established possible explanations for the mechanism of material ejection,” said Emma. “In particular, I found that the process can be optimised at a relatively low exposure level, less than $100 Wcm^{-2}$, enabling large area removal with commercially available laser systems and reducing the potential risk of volatilising radioactive contaminants that may be present in the material.”

A laser scabbled surface. *The block is 100 mm wide and 300mm long. Beam diameter was 80 mm and a 5kW Nd:YAG laser at TWI Cambridge was employed.*

According to Emma, “The advantages of this process are not only in its material removal capability. Using scanning mirrors permits complete remote operation and eliminates the need for heavy end effectors or complicated robotic systems. Both factors give laser scabbling a distinct advantage over competing technologies.”

Emma’s nomination was made by Julian Spencer of BNFL, Emma’s current employer. “BNFL recognises that laser scabbling may not only be of substantial economic benefit to the Company, but may also be of considerable strategic advantage in the decommissioning of nuclear facilities worldwide,” said Julian.

Virtual laser expert comes to life

The Virtual Laser Expert (VLE) is a free web-based service to disseminate laser-related information to potential users. Set up with DTI support, it provides a search engine and an extensive list of Frequently Asked Questions (FAQs) covering both technical and commercial issues related to the industrial exploitation of laser materials processing technology. Enquirers are invited to provide specific questions that are then e-mailed to the VLE panel for a more detailed response. The 35 current members of the VLE panel include research centres, key laser and laser-component manufacturers and suppliers, laser job shops and engineering companies.

At the present time the FAQ answers are incomplete and many are in need of editing. These deficiencies will be rectified before the official launch of the VLE service at the Metalworking 2002 show on 29 April.

February workshop success

Two important AILU annual workshops took place within a two week period in late February, a laser cutting workshop in Liverpool and a Microengineering workshop in Edinburgh. In total they attracted over 150 delegates.

In different ways, aspects of both meetings were new departures in the development of AILU workshops. Liverpool University hosted our first two-day meeting, with the opening day at the Lairdside Centre being the first ‘Essentials’ workshop that the Association has held. At Heriot Watt University the Microengineering workshop was the first AILU event directly linked to a training course. Another new feature of both meetings, a pre-meeting meal for delegates and speakers, proved successful in providing opportunities for informal discussion of ideas.

Reports of these highly successful meetings came too late for this issue but will be fully covered in the next.

Note from the editor

The ‘Design for Manufacture by Laser’ workshop in Bristol last November, featured on the front page of this issue, points the way to an area of AILU’s activities that is sure to receive special attention during the coming year.

If evidence were required to demonstrate that even within existing ‘laser user’ companies there is a need for basic laser processing information, one need only point to the recent ‘Essentials of Laser Cutting’ workshop, where over 80% of the delegates were AILU members.

Workshops, however, are not always effective in reaching design engineers and AILU has been looking at a number of other initiatives. Included in these is the Virtual Laser Expert and last month saw its launch on the AILU web site, where it joined the P&S directory and the applications database as free and open on-line services to stimulate new laser activity.

The last six months have not been good for manufacturing industry worldwide, but the first signs of a return to growth are apparent, providing new opportunities for AILU to launch a ‘Design for Manufacture by Laser’ initiative.

Such new activity would bring a number of obvious benefits for existing members. These include raising awareness of new opportunities for existing users of lasers to expand their use of the technology, creating opportunities for training and, for laser job shops, helping to grow the market by making designers more aware of the benefits of laser-based manufacture. Clearly, a successful initiative would also lead to increased sales for our laser equipment supplier members and would help manufacturers who ‘think laser’ to improve product quality and reduce costs, thereby gaining a significant commercial advantage.

Topics in this issue include medical device manufacture, micromachining, soldering, cutting, rapid tooling and flexure designs, as well as business advice for job shops and users in general. I hope they catalyse many new laser-based ideas for our readers.

A message from the new chairman of the Laser Job Shop Group

When I first heard about the formation of the Association of Industrial Laser Users I was pleased that the industry was, at last, getting a voice. The Association very quickly attained a reputation for its organisation and, especially, the quality and content of its publication *The Industrial Laser User*. However, as far as I was concerned it didn't fulfil my requirements as a sub-contractor.

Then, three years ago, the Job Shop Group was formed to answer the needs of those who were trying to make a living by selling laser processing services. Since that time the group has organised many very successful meetings to keep members up to speed with the latest developments in processing by laser as well as advances in other areas such as gas (and gas delivery systems) and materials etc.

Since its formation, the Job Shop Group was been led firstly by, John Bishop and, latterly, by Sean MacEntee. The mantle has now been passed to me and I will be doing all I can to keep the momentum going and develop the group into one that all laser sub-contractors will want to belong to.

Our enemy at the moment is apathy. It is very difficult, in the present financial climate, to get people to spend money on membership of an organisation they think they can do without. It is our job to prove to them that they cannot do without us. We can do this by continuing with, and improving, our presentations and by providing meaningful data from our member surveys. The surveys carried out by the group provide very useful information, but would be so much better if more of the existing members were to take part. Remember: you don't see the results if you don't take part.


David Lindsey

I will do all I can to see that the Job Shop Group becomes the 'real voice' of the industry but in the meantime there are two things that existing members should consider doing.

Firstly, bearing in mind that satisfied members are our best salesmen, if you know people in the industry who are not already members, call them today – tell them what they are missing.

Secondly, if you are a Job Shop member make sure that you take part in the surveys. This is a service that is included in your membership fee, but you will get no benefit unless you participate.

David Lindsey Laser Process Ltd

European President for LIA


Eckhard Beyer

The Laser Institute of America's 2002 president is Professor Eckhard Beyer, the Executive Director of the Fraunhofer Institute for Material and Beam Technology (IWS) in Dresden, Germany since 1997. He has been an LIA member for more than 10 years.

As LIA president, Beyer hopes to help the society keep up with the times with regards to technology. "We are living in a century of globalisation strongly supported by the internet. LIA has to meet this challenge to hold and stabilise its leading position," he said.

AILU web site updates

The home page of the AILU web site is in the process of a significant upgrade, presenting the applications database, P&S directory and VLE service as a complete suite of solutions for design engineers. Additionally, the list of useful links at *www.ailu.org.uk/links.htm* has recently been expanded to include business and product directories in addition to national and international laser associations, government resources and ELAN, the European Laser Applications Network.

A survey of UK laser research centres was completed earlier in the year and the results can be found at *www.ailu.org.uk/news.* These include full contact details for the various university and commercial centres as well as reviews of recent activities, many of them illustrated. The survey is being constantly updated so members are encouraged to submit updated information at any time

Business briefing for AILU members

UK members of AILU should recently have received a free Business Briefing on 'Global Photonics Applications and Technology', both CD and hard copy versions.

The report, issued by the World Markets Research Centre, provides a strategic overview of communicatiuons and photonic technology in general, including nanotechnology and MEMS. Different laser types are described, optical fibres, laser safety and applications ranging from medical, industrial and machine vision.

Special AILU subscription rate with free copy of Industrial Laser Solutions

In the spirit of the mutually supportive association between Industrial Laser Solutions and AILU, ILS has provided a free copy of the monthly magazine with this issue of The Industrial Laser User and is offering AILU members a special subscription rate of US $125.00 for 12 issues air mailed from the US, a savings of $175.00 US.

Your subscription can be faxed directly to Industrial Laser Solutions in the UK +44 (0)20 7504 8207, or directly to the U.S. at +1 847 291 4816 or +1 603 891 9498, referencing the code N1BAILU. Please remember to provide your complete mailing information. ILS accept VISA, MasterCard and AMEX.

Members' News

Contact details for members' news items

Advanced Optical Technology
Contact: Clive Ireland
T: +44 (0) 1268 522111
F: +44 (0) 1268 522111
E: info@AOTLasers.com

BFi Optilas Ltd
Contact: Peter Marshall
T: +44 (0) 1908 326326
F: +44 (0) 1908 221110
E: peter.marshall@bfioptilas.av.net.com

BLM-Adige (UK) Ltd
Contact: Paul Lake
T: +44 (0) 1525 402555
F: +44 (0) 1525 402312
E: paul.blm@dial.pipex.com

Bofa (UK) Ltd
Contact: Derek Roberts
T: +44 (0) 1202 666789
F: +44 (0) 1202 649933
E: sales@bofa.co.uk

CHK Engineering Ltd
Contact: Alan Pinkney
T: +44 (0) 1270 255520
F: +44 (0) 1270 211263
E: sales@chk-engineering.co.uk

Cutting Edge Metal Processes
Contact: Bob Lewis
T: +334 431 8015
F: +334 431 7848
E: LEWS@bendership.com

Exitech Ltd
Contact: Malcolm Gower
Long Hanborough OX8 8LH
T: +44 (0) 1993 883324
F: +44 (0) 1993 883334
E: m.gower@exitech.co.uk

Electrox Ltd
Contact: Malcolm White
T: +44 (0) 1462 472400
F: +44 (0) 1462 472444
E: sales@electrox.com

GSI Lumonics Ltd
Contact: Louise Partridge
T: +44 (0) 1788 532611
F: +44 (0) 1788 541094
E: Partridgel@gsilumonics.com

Guttridge Services Ltd
Contact: Peter Guttridge
T: +44 (0) 1775 765300
F: +44 (0) 1775 765303
E: laserfab@guttridge.co.uk

Heriot-Watt University
Contact: Julian Jones
T: +44 (0) 131 451 3031
F: +44 (0) 131 449 5542
E: j.jones@hw.ac.uk

Hi-Tech UK
Contact: Phil Mullins
T: +44 (0) 1709 763000
F: +44 (0) 1709 763001
E: sales@purexltd.co.uk

HSE
Contact: Steve Walker
T: +44 (0) 151 9514723
F: +44 (0) 151 9514845
E: steve.dst.walker@hse.gsi.gov.uk

JETCAM (UK) Ltd
Contact: Martin Bailey
T: +44 (0) 1684 892290
F: +44 (0) 1684 892269
E: mbailey@jetcam.co.uk

John Parker & Son
Contact: John Tyas
T: +44 (0) 1227 783438
F: +44 (0) 1227 783824
E: john_tyas@parkersteel.co.uk

Kentek
Contact: Andy Toms
T: +44 (0) 1737 778000
F: +44 (0) 1737 771908
E: andy@trident-uk.co.uk

OR

Contact: Kris Tripp
E: ktripp@kenteklaserstore.com

LaserAge, Ireland
Contact: Leo Sexton
T: +353 21 4899 723
F: +353 87 608 0919
E: info@laserage.ie

Laser Lines
Contact: Gary Broadhead
T: +44 (0) 1295 672500
F: +44 (0) 1295 672550
E: info@laserlines-im-co.uk

Lasermet
Contact: Paul Tozer
T: 01202 770740
F: 01202 770730
E: paul@lasermet.com

Laser Process
Contact: David Lindsey
T: +44 (0) 1543 466676
F: +44 (0) 1543 466679
E: sales@laserprocess.co.uk

Laser Trader
Contact: John Cocker
T: +44 (0) 1246 267714
F: +44 (0) 1246 269381
E: johnc@lasertrader.co.uk

MJ Technologies
Contact: Jason Duffin
T: +44 (0) 1530 815501
F: +44 (0) 1530 811519
E: MJT@MJT.UK.COM

NG Bailey Manufacturing
Contact: Martin Cook
T: +44 (0) 1274 704901
F: +44 (0) 1274 723148
E: martin.cook@ngbm.co.uk

Oxford Lasers
contact: Alan Ferguson
T: +44 (0) 1235 554211
F: +44 (0) 1235 554311
E: alan.ferguson@oxfordlasers.com

Pro Laser
contact: Mike Green
T: +44 (0) 1235 550522
F: +44 (0) 1235 550499
E: mike@prolaser.co.uk

Pullmax
contact: Kevin Brien
T: +44 (0) 113 2976666
F: +44 (0) 113 2223198
E: kbrien@pullmax.co.uk

Rofin-Baasel UK
Contact: Andy May
T: +44 (0) 870 9901020
F: +44 (0) 870 990 1030
E: a.may@rofin-baasel.co.uk

Rutherford Appleton Laboratory
Contact: Dr AJ Landley
T: +44 (0) 1235 446810
F: +44 (0) 1235 554211
E: a.j.langley@rl.ac.uk

Spectra-Physics Lasers Ltd
Contact: Jon Richardson
T: +44 (0) 1442 258100
E: sales_uk@spectra-physics.com

Spemco Group
Contact: Steve Driver
T: +44 (0) 1634 225002
F: +44 (0) 1634 225028
E: mail@spemco.co.uk

Thermo Temperature Control
Contact: Alistair Moffatt
T: +44 (0) 1928 562655
F: +44 (0) 1928 562656
E: alistair.moffatt@neslab.co.uk

TWI
Contact: Steve Shi
T: +44 (0) 1223 891162
F: +44 (0) 1223 892588
E: gongqi.shi@twi.co.uk

UMIST
Contact: Lin Li
T: +44 (0) 161 2003816
F: +44 (0) 161 2003803
E: lin.li@umist.ac.uk

University of Hull
Contact: Howard Snelling
T: +44 (0) 1482 466078
F: +44 (0) 1482 465606
E: h.v.snelling@hull.ac.uk

University of Liverpool
Contact: Ken Watkins
T: +44 (0) 151 7944820
F: +44 (0) 151 7944585
E: kwatkins@liv.ac.uk

Julian Jones honoured with OBE

Julian Jones, OBE

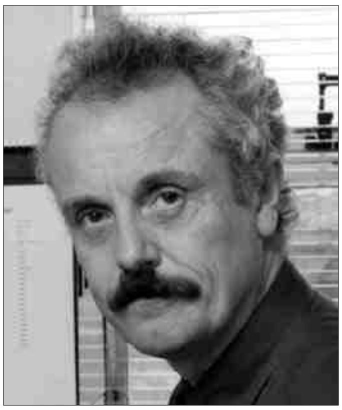
AILU-member Professor Julian Jones of Heriot Watt University was appointed as an Officer of the Order of the British Empire, OBE, in the New Year's Honours of 2002, 'for services to science and engineering'.

Julian studied physics at the University of Wales, Aberystwyth, where he gained his BSc and in 1980 a PhD on the plasma chemistry of excimer lasers. In 1988 he moved to Heriot Watt University, Edinburgh where he established a research group specialising in optical fibres, including high power beam delivery and laser material processing. With his group, he has published nearly 500 journal and conference publications and patents on these subjects. He is currently Professor of Engineering Optics, Head of the Department of Physics and Head of the School of Engineering and Physical Sciences at Heriot Watt University.

Julian is an active Fellow of the Institute of Physics. He is current Chairman of the Applied Optics Division and the Programme Committee for the Applied Optics and Optoelectronics conference, which will this year be held in Cardiff from 2 to 5 September as part of the event 'Photon 02'.

Julian has also made many contributions to the work of the Engineering and Physical Sciences Research Council, where from 1996 to 2001 he was a member of the 'Technical Opportunities Panel whose principal responsibility was in advising the Council on its strategy and the balance of resources between Programmes. He continues as a member of the Strategic Advisory Panel for the Basic Technology Programme.

Recognition of laser activity at Liverpool



Ken Watkins

In recognition if the importance of laser activity in research and teaching in the Department of Engineering at the University of Liverpool, Ken Watkins has been appointed Professor of Laser Engineering from 1 January 2002.

A key development in the coming year at Liverpool will be the introduction of a Masters degree in Engineering Applications of Lasers that can be taken on a part-time basis. The eight one-week modules can be assessed in any combination over a period of one, two or three years and the research project can be carried out in the workplace where suitable laser facilities exist. This version of the course will operate from October 2002.

Welcome to New Corporate Members
(since December 2001)

NMB UK Ltd

Kentek

CSIR (National Laser Centre)

Laser Age

Bristow Laser Systems UK Ltd

Messer UK Ltd

Lasers in shipbuilding at Cutting Edge

AILU member Cutting Edge Metal Processing, Inc. is the 1st Operations Shop at Bender Shipbuilding & Repair Co., Inc., located in Mobile, Alabama, USA. It is an all-new material preparation shop built to support Bender Shipbuilding but it also supports Tampa Bay Shipbuilding and Repair Co., Inc., located in Tampa, Florida. In addition, the company solicits external business as capacity allows.

The Tanaka 6 kW CO_2 system in action

"The shop came into being in 1999 after an intense round of decision-making concerning the use of a laser versus more conventional cutting processes. This decision followed several fact-finding trips to shipyards in Europe and the Far East. The laser has proven a great step forward for our yard in many ways. The extreme accuracy of the resultant parts has cut our steel work costs dramatically," said General manager Robert Lewis. "Even those in our company who were dead against anything but a plasma cutter now admit that this was a wise move," he added.

Cutting Edge use a Tanaka 6 kW CO_2 LMXIII, which has a 4 m wide cutting bed, 42.7 m long. The machine is used to cut a wide range of parts from small (50 mm square) to large (3.5 m x 15.3 m) and in thickness from 6 mm to 25 mm. Almost all plate is blasted and primed in-house before cutting with one of several zinc-rich weldable primers, and because of the high zinc content, we vaporize the cut path and etch 'fitting' and 'forming' lines prior to actual cutting. "Our average cutting thickness is in the 9-13 mm range but we cut 19 mm on a steady basis, sometimes for days on end," said Lewis.

Lewis added, "We currently operate 24/7, typically cutting about 247,000 kg of plate in a seven-day period. Everything we do is on a JIT basis so scheduling, sorting, and kitting is a very important part of our process. In addition to the laser cutter, we have an automated blast/paint booth that will handle plates up to 4 m wide, a 185 ton ironworker and an 1100 ton NC press brake with a 7.3m bed and an automated variable width bottom die. All plate is handled by horizontal plate magnets."

UMIST expands laser facilities

UMIST has recently purchased 4 new high power laser systems to add to its range of laser processing facilities. These comprise a 1.5 kW diode laser with optical fibre beam delivery from laserline GmbH, a T80-YHP4 Q-switched Nd:YAG/YVO_4 laser from Spectra-Physics, capable of operating at three different wavelengths, a 2 kW slab CO_2 laser from Rofin-Sinar and a 100 W CO_2 laser marker from Bfi Optilas and Spectron Lasers. These laser systems will be placed in the Laser Processing Research Centre and the Corrosion and Protection Centre. UMIST laser processing research involves drilling, cutting, rapid tooling, marking/engraving, micro-engineering and surface treatments.

Guttridge expands laser cutting

Guttridge Laserfab, a division of Guttridge Services Ltd, have recently extended their laser cutting capacity by installing a second Bystronic machine at their new factory, located on the outskirts of Spalding, Lincolnshire.

Their latest acquisition gives a larger bed size, 4 m x 2 m, as well as an increase in cutting capacity to 20mm mild steel, 15mm stainless steel (clean cut) and 8mm aluminium. Once again, Guttridge Laserfab took the additional option of rotary axis capability, for laser cutting of tube and box section materials.

"The laser machines compliment our CNC and manual manufacturing capacity, enabling us to supply from small components to fully assembled painted/powder coated units," said managing Director Peter Guttridge.

"Our new factory now houses some of the most sophisticated sheet metal manufacturing capacity available to sub contract companies of this nature," he added.

CHK continues to grow and develop

Following CHK Engineering's purchase of a Finn Power FPL6 in April 2001, the company has gone from strength to strength with a much-expanded order book and several more high profile customers on board. As a result, CHK has taken on a new sales manager to set up a sheet metal division within the first of the company's major factory extensions. In line with this, the Crewe-based company have purchased another Finn Power machine, a Laser Punch L+P, which carries out load, punch, laser-cut and unload operations and will thereby bring considerable time and cost savings.

"This is yet another example of CHK's commitment to continuous improvement, and to remain a leader in its field," said Managing Director Alan Pinkney.

"The production team has recently set up a lean manufacturing cell to produce one of the company's major parts in the most time, labour and cost effective way possible. This all round quality is recognised by CHK's suppliers, evidence of which is a recent award from Lex Auto Logistics, who have named CHK as a preferred supplier," said Pinkney. "Only 15 of Lex's 1000 suppliers have achieved this accolade," he added.

CHK are always happy to welcome visitors to the site (by prior arrangement), and are holding an open day in May. Contact Brian Billings or Craig Newhouse at CHK to receive an invitation to this event.

Berthold Leibinger Innovationpreis 2002

The technology of applied laser physics is due to be given special recognition with the Berthold Leibinger Innovation Prize. Awarded every two years the prize is given to scientists, physicians and development engineers for outstanding research work in laser medicine. Individuals as well as project groups are eligible to participate.

An international jury will appraise the work submitted in terms of its level of innovation, scientific quality, technological creativity, practical utility and synergy effects with regard to industrial application.

The prize winners will receive the following sums, first prize 20,000 Euro, second prize 10,000 Euro and third prize 5,000 Euro.

Application forms can be obtained from the internet *http://www.leibinger-stiftung.de or* by writing to the foundation:

Berthold Leibinger Stiftung GmbH
Postfach D-71252, Ditzingen, Germany

For further information contact Dipl.-Phys.Sven Ederer at:
T: +49 71 56 / 303 1559 F: +49 7156 / 303 208
E: innovationspreis@leibinger-stiftung.de
Deadline for submission 31 March 2002

LAMP launched at Hull University

The University of Hull Masters Training Package in Laser Applications in Micro-machining and Processing (LAMP) was launched with its first intake of students on 1st October 2001. Supported by EPSRC, LAMP addresses the skills and qualifications shortages in high-tech laser applications and leads to the award of a MSc degree. A number of funded studentships are available for the 2002 intake on a competitive basis.

The in-house expertise of the Physics Department at Hull is supplemented by case studies presented by guest speakers. A major part of the training is the practical project undertaken by students in their final semester.

Anyone interested in supporting this programme by offering their expertise or providing a practical project, which may be an industrial placement, should contact Howard Snelling at the University of Hull. Details can be found at *www.hull.ac.uk/LAMP.*

Femtosecond Laser Facility Available

The Central Laser Facility (CLF) at the Rutherford Appleton Laboratory, Didcot is making available its femtosecond multi-terawatt laser facility, Astra, to industrial and academic researchers for high intensity experiments.

Operating at a fundamental wavelength of 800 nm, the laser provides up to 300 mJ pulses of duration as short as 50 fs and focused intensities up to 10^{19} W/cm^2 on target. Pulse repetition rate can be varied up to 2 Hz, or up to 10 Hz at intermediate energies. Operation at 400 nm is also available.

Experienced staff operate the laser and provide technical support and advice on the design and execution of laser experiments. A wide range of supporting equipment and diagnostic instruments are also available.

For further details please contact Dr A J Langley at Rutherford Appleton Laboratory. Details are also available at our website *http://www.clf.rl.ac.uk/astra*.

Supply of laser equipment

Request received from the AILU web site

Dear Sirs,

We are inviting offers for regular, long-term supply of laser equipment with the following features:

1. Small and portable.

2. Battery-operated.

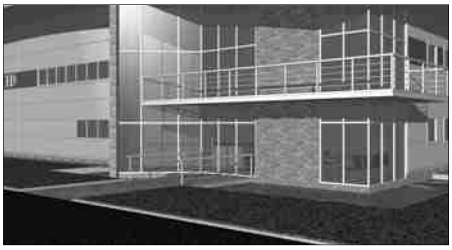
3. Capable of emiting a powerful, invisible beam of light to deter an aggressive animal (example, a wild buffalo) from charging at you from a distance of about 100 meters. This equipment must not cause any physical harm to the animal. Perhaps, it would only cause a burning sensation at the point of contact, to deter the animal from advancing towards you.

This equipment is intended for self-protection by wild-life rangers in jungles.

You are invited to submit your offers for supply of this equipment together with your product info, price and delivery details for our attention.

Originators details withheld but available from the AILU office

New laser facility for Laser Process



Model of the new Laser Process factory

Work has commenced on a new state of the art laser processing facility in Hednesford, Cannock. The development, for Laser Process Ltd, is on the prestigious Keys Park development. The £950,000, 15,000 ft^2 unit will enable the company to continue the growth it has enjoyed over the last twelve years. The new building will be ready for occupation in August.

On completion of the building works Laser Process will be installing one of the latest Trumpf laser cutting systems representing a further £350,000 investment bringing the total to £1.3M.

Parker acquires Yeowart Steel

Steel stockholder John Parker & Son of Canterbury has acquired the business of Sussex-based firm Yeowart Steel Stockholders. The deal makes John Parker & Son the leading steel and non-ferrous stockholder and processor in the South of England. Yeowart, based at Crawley, is a family-run firm with around 80 employees.

Guy Parker, Managing Director of John Parker & Son, said "The market in the south of England has considerable growth potential. In view of its high quality operation and convenient central location, Yeowart was a logical acquisition for Parkers. Customers will have access to a much wider range and volume of stock and leading-edge metal processing services, including laser and plasma cutting."

600 Group consolidation

In a move designed to consolidate its laser manufacturing facility, Letchworth-based Electrox, part of the 600 Group and designers and manufacturers of state-of-the-art CO_2 lasers, has taken over fellow Group-member Profile 600.

Malcolm White unveils a Lazerblade laser profiler

Following the acquisition, the design, manufacturing and support services of the two companies will be under the control of a single team, with the aim of delivering a range of class leading products that will include the Lazerblade laser profiler. Furthermore, the integration of the companies research and development capabilities should lead to further new products offering laser-based solutions in a variety of applications.

Speaking of the acquisition, Electrox managing director Malcolm White says: "Electrox's takeover of Profile 600 marks an important turning point in the company's development and reflects the dynamism of a manufacturer whose continued growth is the result of its ability to satisfy market demand."

International SEMATECH to purchase EUV MicroExposure Tool from Exitech

International SEMATECH has placed the first purchase order for an MS-13 Extreme Ultraviolet (EUV) Microstepper, to be built by Exitech and installed in ISMT's Resist Test Center. This groundbreaking microexposure tool (MET) will help speed the development of resists for next generation post-optical lithography.

"By 2007, if we are to stay on the industry's historic productivity curve, the manufacturing requirements of 16Gbit memory and 6GHz processor chips will call for photolithography on wafers with critical feature sizes as small as 45-65nm," said Malcolm Gower, Chairman and Technical Director of Exitech. "Extreme Ultraviolet (EUV) lithography will help us achieve such fine critical dimension features."

The MS-13 EUV Microstepper, which will be installed at ISMT during the fourth quarter of 2003, will incorporate a dense plasma focus discharge source with a wavelength of 13.5nm, as well as a 0.3NA EUV imaging lens. The tool is targeted to resolve minimum feature sizes of 35nm and below. International SEMATECH sponsored the development of the MET optics as part of its EUV Lithography program. Mirrors of the 0.3NA lens will be polished to the smoothness of a single atom (0.2nm), coated with specially developed multiplayer reflective layers, and then aligned to one another with a precision of 1nm.

The microexposure tool will be used to develop EUV photoresists in International SEMATECH's Resist Test Center (RTC), as part of ISMT's efforts to develop the necessary infrastructure for EUV lithography. "Our Resist Test Center is a unique facility, dedicated to developing the advanced 157nm and EUV resist materials required for future semiconductor processing," stated Gene Feit, ISMT's Resist Program Manager. "The RTC's doors are open not only to our members, but also to resist manufacturers and developers from around the world, who will use the MET to evaluate a wide range of potential photoresists."

Additionally, the tool will provide early learning development on EUV lithography processing, allowing ISMT and Exitech to study production tool issues such as performing lithography processing in a vacuum environment and employing all-reflective optical components and reticles.

International SEMATECH (ISMT) is a global semiconductor technology development consortium that has effectively represented the semiconductor manufacturing industry on innovation issues since 1988. Its members are Agere Systems, AMD, Conexant, Hewlett-Packard, Hynix, IBM, Infineon, Intel, Motorola, Philips, STMicroelectronics, Texas Instruments and TSMC. ISMT conducts state-of-the-art research and development, and is a highly-regarded technology partner whose mission is to promote the interests common to all chipmakers. It has extensive experience collaborating with equipment and materials suppliers, as well as government and academic research centers, to refine the tools and technology necessary to produce future generations of chips. Additional information may be found at *http://www.sematech.org*.

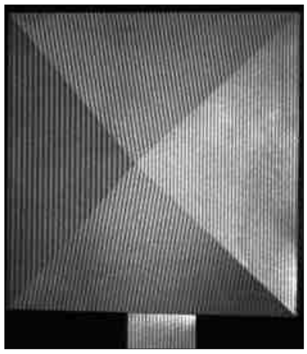
Exitech on the move


Exitech's new factory in Yarnton

Exitech is in the process of vacating its premises in the Long Hanborough business park for a bigger building in Yarnton, near Oxford.

The new location is a a brand-new factory built for laser-manufacturer JDS Uniphase and includes a suite of clean rooms. The total building area is 57,000 ft^2, of which 20,000 $ft^2$is cleanroom area. It was occupied for a few months and then vacated.

Heriot-Watt aids prototype production


Fringe pattern on a test object.

A consortium comprising Point Source (Hamble), Land Rover, Heriot-Watt University, Cybamatic and VAW Motorcast has developed Photoform, a non-contact measurement shape acquisition system for reverse engineering with high speed and accuracy.

A camera records the shape of interference fringes projected from different positions to provide absolute distance measurements for points on an object surface.

NG Bailey improves with ISO 9001

NG Bailey Manufacturing, the Bradford-based sub-contract laser cutter, has recently been accredited with the new ISO 9001: 2000. The exercise has already allowed the company to eliminate non value-added activities in many key areas. Considerable benefits in customer satisfaction, productivity and cost control are anticipated.

The company is basing a process improvement project on the new standard, and aims to reduce non-value added activity by at least 30% within the next 6 months. Successes to date have included a 30% increase in efficiency within engineering and a 50% increase in the number of quotations generated per day. General Manager Martin Cook commented, "The new standard is a genuinely useful business management tool. It allows us to measure how good we are in all areas and, more importantly, change a process quickly if it's not working. For the first time, people can actually see the impact their actions take responsibility for the quality of their output."

HSE funds TWI laser guard study

The Health and Safety Executive has recently agreed to sponsor a project proposed by TWI to assess laser machine guards.

"Laser materials processing is increasing in industry and tending towards higher laser powers and multi-axis work," said AILU-member Steve Walker, HSE Specialist Inspector in ionising and non-ionising radiation. "Standards for laser guarding of machines are available, including EN 60825-4 'Laser Guards', but little hard data is available on the performance of guard materials, thus making it difficult for laser users, manufacturers, system builders and HSE Inspectors, to be sure that enclosure designs are safe."

"During this 18-month project we will test a range of materials currently used for laser safety enclosures, including measurement of damage threshold and burn-through time for the laser powers and wavelengths used by industry," said TWI project manager Steve Shi. "The main benefit of this work will be to confirm the suitability of commonly used materials, assess new materials and provide laser users and machine manufactures with guidance on guard design and safety assessment," he added.

Pro Laser Consultants have been contracted by TWI to assist in the preparation of a guideline document for laser users and manufacturers and to provide an interface with the international technical committee responsible for the on-going development of the 60825-4 standard.

Spemco grows its PCB work

"At the end of this financial year we will have achieved a 16 per cent growth in turnover," said printed circuit board manufacturers Spemco Managing Director Steve Driver. "The increase in business is regarded as extraordinary throughout the PCB industry, given that most other printed circuit board manufacturers will be reporting major falls in turnover," he added. "Profits are down, mainly due to the downturn in the telecoms industry, but given the state of the marketplace generally, we have to be pleased with our results."

Spemco has emerged from the industry downturn not unscathed, but a good deal wiser and better equipped for whatever the future may hold. "Initially we turned to entrenchment, then consolidation, finally realignment," said Driver. "Entrenchment was forced on us when we had £160,000 of telecoms work suspended, then cancelled, following the September 11th terrorist attacks in the United States. But the downturn in business had started well before that. We had seen business decline since about May 2001, with June our worst month ever. So the September cancellation of orders was not only the culmination of a bad year but the catalyst which forced us to cut overhead costs and seek to realign production in order to adapt for work that could be available to us."

"Then we set about consolidating our activities. We've now moved the production quantities of PTH boards from Rochester to Portsmouth leaving the Rochester factory with capability for prototype PTH only. This means that instead of having two plants with 60% capacity we now have our Portsmouth factory working to full capacity and a more efficient and responsive Rochester factory."

"In the past we've had to turn low value orders away, the £100 and £150 orders – they just weren't profitable. Now, though, we have devised an economic method of manufacturing small, low-value orders. Engineers at Rochester collating lots of small orders onto the same panel and transfer it as a single job lot to the Portsmouth factory. This way Portsmouth receives on order for, say, £1200 or £1500, which, in reality is six orders for six customers. It's a very different concept to anything we've ever done before and has opened up new opportunities by making it economically possible to deal with small orders. A total of 144 new small order accounts has already brought in over £500,000. We've also introduced a new credit card payment service."

"We finished 2001 with the best order book we've had for seven months,"said Driver.

Leo launches LaserAge in Ireland

Leo Sexton

Leo Sexton is a laser engineer with a wide research qualifications and over 10 years experience in the field of laser materials processing including a PhD from Liverpool University, a post doctoral Newman Fellowship from University college, Dublin and experience at the Institut fur Laser technik, Aachen and Sifco, Cork.

"I decided to establish a consultancy, LaserAge, to dedicate my attention to raising awareness of laser technology to manufacturing industry and to help industrial users make the best use of lasers to increase production, reduce production costs and add value to components."

More details can be found at *http//:www.laserage.ie*

Andy moves to sales at Oxford Lasers

Andy Bell

Andy Bell has become Technical Sales Manager for Industrial Systems at Oxford Lasers, joining Adrian Baughan in Sales.

Andy spent 7 years in the Micromachining Group at OLL, developing processes and designing bespoke systems. "My experience as Project Manager for micromachining systems for the 3 years prior to my transfer to Sales will be a great help," said Andy.

New appointments at GSI Lumonics

William "Bill" Leblanc

William "Bill" LeBlanc, a native of the USA, has been with GSI Lumonics for over fifteen years and has now moved to the UK with his wife and family of three to take over as the General Manager of the Rugby facility. Bill, supported by the rest of the local management team, has been instrumental in mapping out the future of the group in Rugby

Simon Wheatley

Other key appointments at the Rugby facility in 2001 include Simon Wheatley as Head of Marketing for Rugby Products world-wide, and Louise Partridge as Sales Manager – Northern Europe.

Simon Wheatley has worked for GSI Lumonics for 13 years. He worked in Operations, building and testing lasers, before moving into Product Development, where for five years he managed one of GSI Lumonics new product development groups. He was the Product Line Manager for Rugby's three product lines until assuming his present responsibility.

Louise Partridge

Louise Partridge a 12-year Lumonics veteran is well known in the UK market. Based in Rugby, Louise will continue to serve customers in the UK, supported by the Rugby Applications Lab, headed by Dr Mo Naeem.

Craig moves to the USA

Craig Bratt

Late last year Craig Bratt moved from the Product Applications department at Corus Port Talbot to the Fraunhofer Centre for Laser Technology in Plymouth, Michigan.

"Since early 2000 the CLT it has been located in a new facility with $7 M of varied, state of the art laser equipment," said Craig.

"I am working mainly on process development, and one of the challenges is getting to know the a variety of laser sources and equipment on hand, as well as I knew the 5kW CO_2 set up at Corus!

"Life here is both exciting and challenging in many ways, and hopefully I can adapt to the peculiarities of the USA way of life," said Craig. "I would like to send my regards to everyone I know in the UK laser community," he added.

Craig can be contacted at: *cbratt@clt.fraunhofer.com*

Mike heads sales at MJT

Andy Bell

Mike Holyoake has joined M J Technologies as Sales Manager. He initially gained expertise in the toolmaking business and has been involved in EDM Machine Tool sales for the last 15 years.

"I look forward to an exciting challenge to helping the MJT team establish partnership agreements with customers and provide total solutions to their individual technical and machining problems,"said Mike.

Steve and Ulrich join Rofin-Baasel

Steve Crowe

Steve Crowe has joined Rofin-Baasel UK as a Sales and Applications Engineer for their high power Nd:YAG and CO_2 macro product range. Steve graduated as a Manufacturing Engineer in 1998 and worked as a production engineer in a metal fabrication job shop. More recently he was a Programme Officer at the Center for Advanced Joining in Coventry University, mainly working on industrial laser cutting and welding applications development.

Ulrich Schiegg

Ulrich Schiegg has recently joined the sales team at Rofin-Baasel UK in Daventry, to strengthen the micro-processing team. Ulrich worked on the development of the thin disc laser at the University of Stuttgart. Four years ago he joined Baasel Lasertech in Starnberg as an application engineer. There he was responsible for the micro welding and cutting process development and demonstration mainly using pulsed Nd:YAG laser machines.

'I see my move an opportunity to offer our customers in the UK appropriate solutions for their micro processing tasks,' said Ulrich.

New dynamism at GSI Lumonics at Rugby

JK Lasers was founded in Rugby in 1972 and became Lumonics Ltd in 1993, which in turn became part of GSI Lumonics in 1999. Then in December 2000 a stop was placed on the development of the high power CW Nd:YAG Multiwave at Rugby and significant staff reductions were announced. "Certainly, if you were to believe everything you heard on 'the laser grapevine', you might be forgiven for thinking that the company had disappeared off the face of the planet," said Simon Wheatley, Head of Marketing at Rugby.

Nothing could be further from reality – but things have moved on. A change in strategy forced largely by the changing conditions of the markets, meant that for much of 2001 the company's efforts were directed internally at rebuilding the business around its core markets and skills.

"The laser marketplace is exceptionally diverse and many companies have lost their way by trying to do too much," said Simon. "Throughout 2001 we considered the technology available to us, the needs of the various markets – and of course the current condition of the capital equipment market in the UK and beyond. We called over one thousand laser equipment users world-wide to get their input. This provided much useful detail, but some clear and simple messages also emerged."

According to the survey, the predominant view of manufacturing industry is that lasers cost too much to buy, cost too much to operate and are too complicated. As one USA respondent put it, 'I want to get on with making our products, not paying to understand yours.'

"As a result of this survey, we have placed special emphasis on 'lifecycle cost reduction' in the design of our products, striving for lower capital cost with lower running costs" said Wheatley. "Simply achieving one of these goals whilst adversely affecting the other is fruitless," he added.

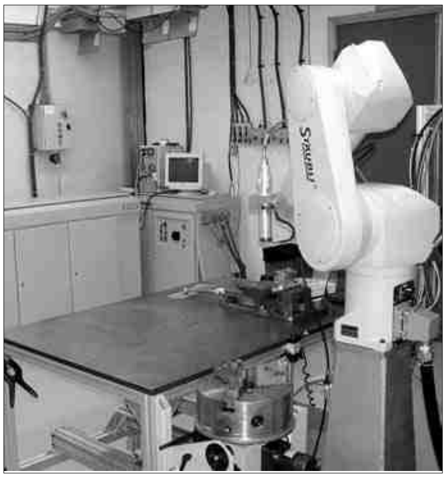
"This year GSI Lumonics, Rugby will be releasing 10 new products, starting in March – each product designed to reduce the 'lifecycle' cost for the market it is intended to serve."

"This year GSI Lumonics, Rugby will be releasing 10 new products, starting in March – each product designed to reduce the 'lifecycle' cost for the market it is intended to serve. Plans for 2003 and beyond look to move this goal further, making the need for innovation essential – not only to get brighter, but also lower cost.

New applications laboratory

In preparation for the launch of several new product ranges, GSI Lumonics at Rugby have been making further investment in their applications facilities. The expanded applications laboratory provides facilities for testing and developing laser processes for the whole range of markets covered by the company's solid-state laser products in Europe – electronics, aerospace, automotive, medical, nuclear and all areas of precision engineering. Similar facilities exist in Farmington Hills, Michigan to support the US markets.

Simon Wheatley said, "We have refocused our business on the applications for pulsed lasers and CW lasers up to 2kW average power. With 10 new product launches planned for this year it is essential that our applications team have a world-class facility in which to develop cost-effective production solutions for our customers". The labs received major investment two years ago when GSI Lumonics centralised applications support for Europe to their flagship facility in Rugby. "This additional investment of around £500,000 ensures that we can demonstrate the whole range of applications that our new products are capable of addressing," commented Wheatley.



Staubli robot ready for 3D processing

The suite of 5 labs is organised according to the needs of particular applications. The CW laser lab covers a range of 6 products, from 400W with very high beam quality for precision cutting and fine welding, up to 2kW for general-purpose fabrication. "Work-handling requirements for these lasers are extensive," explained Lab Manager Dr Mo Naeem. "Component sizes for the CW lasers vary from high speed flat sheet welding trials, where we can handle samples up to 1.5m long, through 3D cutting and fabrication which we typically carry out using the Staubli robot. At the other end of the scale the same lasers are used for high speed welding of small cylindrical components such as fuel injectors, for which we use a very fast rotary table."

The first of three pulsed-laser labs is awaiting the imminent delivery of a new 5-axis workstation from Pyramid Engineering which will be married up with two of the new models in the revitalised JK700 Series. Providing for both direct or fibre optic beam delivery and handling components up to ~0.5m^3, this workstation will address the vast range of precision welding applications for which pulsed solid-state lasers are so well suited. The second pulsed-laser lab houses two more lasers and concentrates on high-quality drilling applications, primarily for the aerospace industry, and high-precision cutting applications for electronics and micro-engineering. The third of the pulsed-laser labs contains a 100W LuxStar laser with both precision tables and galvo-motor beam delivery to address the myriad of spot welding applications in the electrical, electronics and fine-mechanics market sectors. Flexibility is further increased by the addition of a small "portable" workstation for high speed cutting or welding applications, which can be moved into any of the labs as required.

A new custom Data Management System from Keith Withnall Associates is used to access optimised laser process parameters. "Over the years we have performed thousands of processing trials and we were finding it increasingly difficult to get the full benefit of this experience, but the new DMS enables us to quickly search through thousands of previous results to find optimum starting parameters for almost any combination of process, material or thickness," said Mo Naeem. "The system also makes it simple for our engineers to record trial results and produces the reports that our customers and sales people need, as well as handling the scheduling for the labs and customer visits. We anticipate significant improvements in efficiency as a result of this investment in custom software," he added.

Volume Fibre Bragg Grating Production offered by Oxford Lasers

Oxford Lasers has launched the newest member of its specialised family of UV lasers designed for fast, cost effective, round-the-clock, Fiber Bragg Grating (FBG) manufacture. The FBG Ultra has an average UV power up to 1 W, a power stability of 1% rms over an 8 hour period, and claims exceptional grating reproducibility and high yields in a production line environment. In addition, the Ultra boast a low power consumption (less than 4 kW) and low water cooling requirement.

FBG Ultra - The Ultra Stable Answer to Volume Fibre Bragg Grating Production

For the successful production of top quality gratings, beam quality is a paramount consideration. The FBG Ultra has a beam diameter of 2 mm with pointing stability of better than 0.01 mr C^{-1}. These consistent beam parameters also ensure highly reproducible grating quality, sharper grating response and accurate performance, without the need for elaborate pointing correction. A long temporal coherence length of 40 mm allows significant flexibility in writing processes and means that FBGs can be produced by both phase mask and holographic techniques.

The new FBG Ultra opens up opportunities in the production of gratings for telecommunications: standard telecoms fibre, hydrogen free fibre, multimode fibres, multicore fibres and planar waveguides. Its high speed production and high yields are equally applicable to standard fibre material, crystalline material like lithium niobate or new materials such as tin doped fibre.

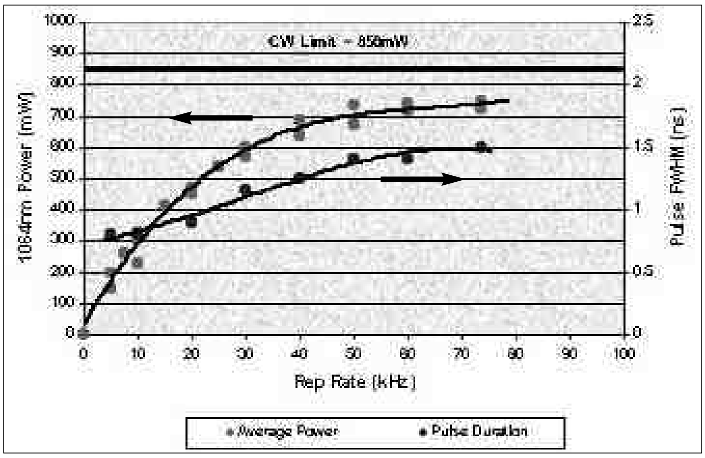
Short Pulse Source for Precision Microprocessing

Clive Ireland
Advances Optical Technology Ltd.

High intensity pulsed diode pumped solid-state lasers (DPSSLs) are now widely used for many applications, especially precision materials processing. Most of these lasers can operate at high repetition rates (10-100 kHz), which allows high processing rates. Predominantly, the lasers use A-O (acousto-optic) Q-switching to generate the pulses since the technique is robust and efficient. However, the A-O technology is fundamentally limited in speed by the acoustic wave velocity and, as a result, the lasers typically produce pulses of ~ 10-100 ns duration.

Shorter, more intense pulses often provide the user with a number of advantages. These arise since the interaction processes are non-linear and because heat diffuses a distance into the target material which scales approximately as (pulse length)$^{1/2}$. As a result, cleaner materials processing is usually achieved with shorter pulses. This has been one of the commercial drivers for AOT to introduce their ACE lasers which use proprietary E-O (electro-optic) Q-switching technology and produce kHz pulses of only 1-2ns duration. Despite this unique performance, are there are many good reasons for AOT to want to extend their technology further, at least over the full operating regime over which high efficiency is maintained.

Research, particularly of materials where electrons dominate heat transport (e.g. metals and semiconductors) indicates a potential significant benefit of further pulse reduction on materials interactions. Pulses of a few hundred picoseconds duration are most likely to coincide with a minimum size for the heat-affected zone. With shorter duration pulses (eg picosecond/femtosecond), electron heating is de-coupled from the lattice and the thermal diffusivity increases, whereas (as noted above) for nanosecond pulses there is more time available for heat flow to take place. As a result, use of pulses in this intermediate regime could lead to a significant advantage for laser materials processing, its character being more akin to extremely localised (clean) ablation rather than the thermal processing characteristic of conventional nanosecond pulse irradiation. If realised, results will be similar to those obtained with much more expensive, bulky and lower reliability short and very short pulse UV and visible sources.



Demonstrator laser performance at 2W pump

Via a current collaboration involving our sister company, Leysop in the UK and a partner Raicol Crystals in Israel, AOT is more fully exploring the operating envelope of its unique laser technology. Recently, the company has demonstrated TEM_{oo} laser performance to 75kHz and achieved pulses of duration down to ~ 750ps. The figure above summaries this performance and also shows that the excellent efficiency of current products is maintained in the new operating regime.

Most encouragingly, our work has shown that Q-switched laser sources with even shorter pulse duration are feasible at the same high efficiency. When the new product development is complete in 2003, it is expected that extended-performance ACE laser models will operate from 1-100kHz rep-rate with less than 1ns pulse duration across the range, greater than 30kW peak power, and provide a minimum pulse duration performance below 500ps with very low jitter. These attributes are anticipated to significantly enhance the attractiveness of pulsed DPSSLs to users currently seeking short pulse sources for applications in the area of high precision microprocessing.

New Precitec laser welding heads

The new Precitec YW50 Nd:YAG laser welding head with integral process monitoring sensors.

Precitec have now introduced a complete range of welding heads and monitors for both Nd: YAG and CO_2 lasers. "The new products enable users to achieve better quality and have greater control over the laser welding process. The modular approach enables the heads to be installed on many different systems without difficulty," said John Cocker MD of Laser Trader Ltd, the UK agents for Precitec products.

The YW 50 is a high capacity welding head for Nd:YAG lasers up to 6kW. Features include sensors for damage or pollution of the protective glass, temperature control of the beam splitter and focusing lens and tight integration of the CrossJet gas, inert gas and cooling water, to minimise the head size.

The new SP 50 R welding head is designed for CO_2 laser welding. Features include 360 degrees swivel, temperature and position control of the focusing mirror and the mirror cartridge.

In many industries there is a requirement for efficient process control systems to ensure weld quality is maintained. Precitec offer the Laser Welding Monitor (LWM) for on-line monitoring of welding processes and the Jurca Vision System JVS-QL2000 for 2D control of the welding depth and focus position. A new optical seam tracking system, Laser Path Finder (LPF) is also available to maintain the welding tool on the seam. "Almost any existing welding machine can be adapted without difficulty to incorporate the equipment," said Cocker.

BOFA's New Look Web-site

BOFA (UK)'s web-site has a fresh look for 2002. *www.bofa.co.uk* has been designed to represent the worldwide necessity for a cleaner, healthier working environment. Focusing on extraction and filtration, the new web-site provides information, including:

- Details on extraction and filtration for hand and machine soldering, machine shop and specialised extraction as well as information on the medical and laser industries.
- Within the Laser Industry pages, details on filtration, unit specifications, unit options and a link to the AILU web-site.
- A news page, providing up-to-date coverage of BOFA activities, including product developments.

Lasermet offer LaserSafe PC

In association with GL Services, Lasermet has produced a revised LaserSafe PC. This package is designed for Laser Safety Officers and others who regularly performs risk assessments on lasers or LEDs. It gives consistent and correct answers for calculations of MPEs, AELs, accessible emission, optical density requirements, classification etc.

LaserSafe PC accords with EN 60825-1, EN 60825-2 and EN 207.

Pullmax Bystronic introduce two new products

Pullmax Bystronic has introduced two products into the UK market. The Bystronic Byspeed offers higher productivity levels without compromising accuracy when laser cutting thin gauge sheet metal. In contrast, the Bytube is a modular system offering accurate and economic handling of a multitude of tube geometries.

Byspeed

The dynamic cutting head on the Byspeed is reflected by axes accelerations of up to 30 ms^{-2}. Equipped with a 4 kW CO_2 laser, the high acceleration results in 270 holes/minute of 10 mm in diameter at a centre distance of 15 mm or 600 holes of 2 mm in diameter with a centre distance of 3 mm when cutting thin sheet metal. Accuracy is to within ± 0.05 mm.

The specified speed and accuracy are achieved by using direct helical motor (DHM) drives rather than the traditional linear drive systems. Both axis drives are temperature controlled and sealed to ensure a long life. In addition, the mobile unit (including the cutting head) has been redesigned to minimise inertia. A combined cast iron and steel girder machine frame avoids transference of vibrations.

Bytube

Growth within the tube machining sector has encouraged Bystronic to develop the Bytube. Each of the three available models uses a 3 kW CO_2 laser and is capable of machining round, square or flat material up to 40 cm wide.

A compact model for the fully-automatic production of small tubes, elbows and fitting requires just one rotary and one cutting axis. A second model is designed for both fully automatic and manual handling of round, rectangular and square tubes in lengths up to 3.25 m and in special execution up to 6.5 m or longer. In the third model available, the cutting head comprises of two travelling axes allowing manual handling of flat material up to 40 cm wide and 6.5 m long. An adaptive optic system controlled by sensors integrated in the cutting head ensures that accurate consistent focusing of the laser beam is maintained.

Bystronic Byspeed. *The entire cutting area is surrounded by guards for safety and access is through sliding doors.*

Laser Lines offer laser welding

Laser Lines (Industrial & Medical) Ltd have recently been appointed as the UK representatives for the Alpha Laser range of laser welding hand workstations.

Available in 4 sizes and laser powers, the Alpha Laser workstations have been designed for versatility and ease of use, with applications ranging from the manufacture of the most intricate jewellry masterpieces to the repair of 350Kg injection mould tools. Other uses include the manufacture and repair of dental implants and bridges, manufacture of sensors, and the joining of fine wires. All workstations operate from single-phase electric supplies, and are fully self-contained, needing no external fume extraction or cooling water.

The laser workstations have been ergonomically designed to maximise operator comfort and ease of use.

New products from Spectra Physics

Spectra-Physics have recently launched a number of new products:

- The new **Millennia Vs J**, is based upon an improved laser diode technology and utilises only one Prolite pump diode, thereby significantly lowers the long term cost of ownership due to increased lifetime and lower consumable costs.
- **Prometheus** and **Mephisto**, high stability single-frequency lasers with outstanding stability characteristics from Innolight
- The **Syncro** is the result of the long-term cooperation of GWU and Spectra-Physics. New crystal technology opens up additional wavelength regimes in optical-parametric oscillators design.

Syncro, a synchronously-pumped OPO for ps and fs pulse operation from 0.87µm - 4µm.

Bfi Optilas offers Gam Excimer

The EX50/2000 is a Ultra-high repetition rate Excimer laser from Gam Laser Inc. It is a total metal/ceramic device which, it is claimed, 'provides static and dynamic gas lifetimes unmatched by any other excimer laser.'

'The EX50/2000 excimer laser is a highly reliable and powerful source of ultraviolet radiation in a compact package. It provides average powers of up to 60 watts with KrF at 248 nm and offers the longest available gas lifetimes of up to 2 years of operation between refills for XeCl operation at 308 nm.' The laser is also claimed to have the highest available repetition rate (on ArF, KrF, XECl, XeF, F2), excellent pulse to pulse stability, 1billion pulses between optics service and 500 million pulse without refills.

The EX50/2000 excimer laser is designed for scientific and industrial applications where long term maintenance-free operation is required. Applications include precision micromachining, tuneable laser pumping, marking and semiconductor processing.

Lazerblade success at Fabrication UK

Lazerblade™ in action

Robinson Fabrications Ltd, Halifax have invested in an Electrox 2.5kW Lazerblade™ CNC profiling machine for their new sheet metal subsidiary company, Fabrication UK Ltd.

Specialising in the fabrication of cabinets and guarding for machine tools, Fabrication UK is a good example of a new approach to an old-established manufacturing business. Instead of the old, noisy, haphazard metal-bashing image of guard manufacture, the company's 20,000 sq ft engineering factory boasts a well-ordered, quiet, quasi flow-line under one roof.

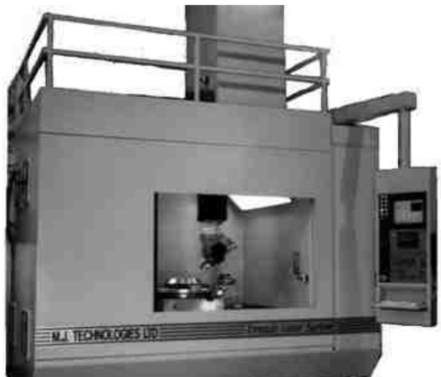
The Lazerblade™ has a 3m x 1.5m capacity and can cut mild steel up to 15mm thick. It can also be used for cutting aluminium and stainless steel, the latter without needing first to remove the protective film.

Thermo offer expanded chiller range

"Thermo Haake refrigerated recirculators are now available to UK OEM customers through the UK offices of Thermo Temperature Control, who continue to offer the full Thermo NESLAB range to all customers. Full Technical Sales and Service Support is available for any temperature control needs from 200 Watts up to 100 KW of cooling.

New laser drilling system from MJT

The Delta Tornado laser drilling system has a number of key advanced features, including three methods of component probing / sensing. The first is a capacitive gap sensing method used for auto focus capabilities. The second method is a nozzle touch probe system used for auto focus, component finding offset correction. The third is a Renishaw touch probe system that is automatically loaded into the head. The combination of these three systems, programmably selectable, gives the system unsurpassed flexibility.

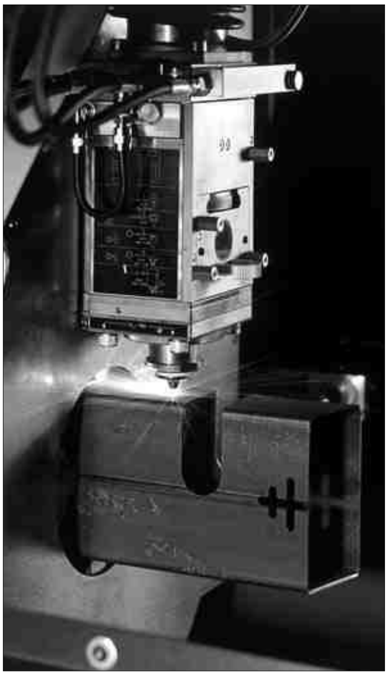


The Delta Tornado also has the ability to produce percussion-drilled holes with variable spot size, using motorised optics. It also offers pulse by pulse energy control and incorporates hole breakthrough detection, a non-intrusive system patented by M J Technologies and probably the only fully functional flexible system worldwide.

The system is rigid and robust and all axes have sliding covers and are pressurised to stop debris penetration. In-built telephone technical support, on-machine documentation and advanced cycles make the machine simple to operate, to support and to maintain.

Laser tube cutting - a process for imagination

Paul Lake
BLM-Adige (UK) Ltd



Italian machine tool Company Adige, part of the BLM-Adige Group, began manufacturing machine tools over 40 years ago, building up a reputation for designing high production sawing machines. In 1988 it became the first manufacturer to design and build a laser-cutting machine specifically for tube cutting. This early machine was little more than a saw that used laser as the cutting medium. Early applications were in the automotive industry, especially the manufacture of exhaust pipes.

In 1991 Adige designed the first version of the Lasertube machine. This was a machine that could not only cut material as a conventional saw would do, but it was also capable of generating any path on round tube. This opened up further markets, particularly in the manufacture of bicycle frames, and sales steadily increased with three machines being installed at the Nottingham manufacturing site of Raleigh. Adige built on the success of the Lasertube concept and in 1996 introduced the Lasertube 651.

Upgrades in CNC control, motors and drives, laser technology and head sensors have continued to be made but the concept of the Lasertube 651 has remained the same. Other developments that were integrated into the 651 machine included the ability to cut not only round tubes but also any regular shaped tube including oval, square and rectangular and these alone created a big expansion in the machine's potential markets as it could now be applied to smaller batch runs and to other application areas such as furniture, shop fittings, food industry, motor cycles, car body and passenger security (e.g. products manufactured for the production of airbags and side impact beams).

"Many of Adige's customers find that they are, initially, only using the machine for five to six hours per day, but within six months they have filled the capacity of the machine due to the new business that they are able to attract."

Tube capacity of the machine is between 12 and 120 mm diameter for round tube, between 12 mm^2 and 100 mm^2 for square tube, and between 15 by 20 mm and 70 by 120 mm for rectangular and oval stock. Length of tube can vary between 3.2 and 6.5 metre.

The accuracy of laser cutting eliminates problems of inaccuracies that tubular components in the past have been prone to and that manifest themselves in the assembly/welding process. The precision and flexibility of Laser tube cutting also permits components to be designed in a way that would not be possible using conventional methods, making them easier and quicker to produce. Many of Adige's customers find that they are, initially, only using the machine for five to six hours per day, but within six months they have filled the capacity of the machine due to the new business that they are able to attract.

The big advantage

Traditionally, tube that required anything other than cutting to length would have to be transferred from a tube cutter to more conventional machine tools for operations such as milling, drilling, punching, pressing and deburring to be carried out. On the Lasertube 651 the laser head can move in the vertical and horizontal planes in order to accommodate round, square, rectangular and oval tube, allowing cutting on the tube end and along the length of the tube at any point on its circumference. Almost any shape can be cut into the wall of a tube, and, if the component parts can be produced from the same tube, kits of parts can be manufactured in a single set-up, greatly reducing work in progress and lead times.

The Adige tube loading system can handle up four tonnes of tube stock allowing long periods of unmanned operation.

The positional accuracy for laser cutting is ± 0.1 mm, repeating to 0.03 mm, but when a feature needs to be machined more accurately the controller initiates a series of measurements, following which the tube is repositioned accordingly and the feature is cut.

The laser head includes a quick-change cassette with a choice of three focal lengths, depending on the material to be cut.

The machine offers various unloading options including a belt and conveyor system for cut tubes over 300 mm in length that will also stack the finished components onto pallets.

The machine is equipped with a Siemens 840 D controller. This has the capability for remote access by Adige's service engineers. Currently over 90 per cent of all service calls are completed by phone/modem as the CNC can be emulated in the service department. Adige offers its own CAD/CAM system to simplify programming of the Siemens controller.

New laser safety screens from Kentek

The Kentek Corporation recently launched the Service Right™ Portable Laser Safety Partition system, a state of the art specialty item for laser service personnel.

"Service Right™ is a compact tri-fold system constructed of durable, lightweight blue FLEX-GUARD™ and is intended for quick and reliable containment of specular and diffuse reflection of laser beams," said Kris Tripp, Business Development Manager at Kentek. "One person can quickly and easily set it up," she added.

Features of this system include a reinforced frame, bright red safety feet and laser-tight connecting flaps on each panel. Each panel measures 0.91 m wide by 1.83 m high, providing approximately 2.7 m^2 of working space.

The system is stored and transported easily in a bag that measures only 1 m long and 0.45 m round and opens completely flat for pack-and-go access. The complete Service Right™ system weighs in less than 12 kg.

The Kentek Corporation has specialized in laser safety products and accessories for over 19 years. In addition to the Service Right™, Kentek offers total safety solutions in the form of stock and custom laser blocking curtains, EVER-GUARD® and FLEX-GUARD™ partitions, viewing windows and many other necessary items for safe laser operation.

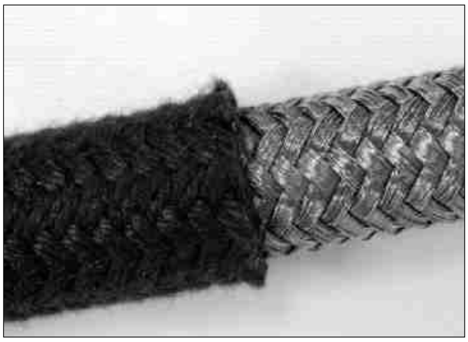
A demonstration of the Service Right™ Portable Laser Safety Partition system will be presented by Trident Systems, Ltd. at the upcoming AILU "What's New in 2002" session on 10 April.

Synrad features on-line applications

SYNRAD's line of sealed CO_2 lasers and scanner heads are used in a variety of industrial processes including cutting, welding, drilling, and marking. The Synrad news brief showcases examples of such applications, a more complete selection of which can be found on-line. AILU members can subscribe at *http://www.synrad.com*.

Recently featured applications include: welding copper-nickel foil, cutting urethane bushings, marking fast bar codes on inked paper, drilling stainless steel, marking PVC. An application example is given below.

for further details, contact UK agent Laser Lines



Courtesy Synrad Inc.

CO_2 laser used to cut the outer fabric housing from a cable.
The outer 0.055" thick housing, consisting of 50% Nomex and 50% Polyester, was cut from the braided steel hose using a Synrad 25W laser. To make the cut, the hose was rotated at 100 rpm with the beam stationary and positioned 1" from the hose end. After the circumference cut was made in 1 revolution, the beam was moved along the length of the housing slicing the material lengthwise to aid in removal. The polyester content in the fabric helps to provide a sealed cut end.

Hi-tech addresses ESD

PUREX Concertina filter for extended filter life

Many processes where dust and fume extraction is necessary, take place in an environment where electrostatic discharge (ESD) can cause problems.

The actual process of air passing through an extraction system can create a static charge. This charge can damage sensitive electronic components, resulting in expensive reject rates. In applications where powder or dust is mixed with the airflow, for example in the chemical handling and pharmaceutical industries, a build-up of static electricity can pose a potential explosion hazard.

To combat this, Hi-Tech UK, in conjunction with customers and research establishments, have developed Purex ESD safe air extraction and purification systems. A material comprising of 30% stainless steel fibres has been used in the patented knuckle joints and air flow valves to create earth continuity in the extraction arms. Purex systems are used in many applications where ESD can be a potential problem, for example in cleanrooms, laboratories, circuit board production, handling of sensitive components and reworking.

Hi-Tech UK have just released their new Laserex brochure, covering products specifically designed to extract and purify contaminated air from laser coding, marking, welding, etching and cutting operations.

New CADCAM & JETCAM software

CADCAM's PEPS TubeCut.

Camtek Ltd has launched a sister product to its successful PEPS PentaCut 5-axis laser CADCAM software - PEPS TubeCut.

Designed for tube cutting using rotary axis laser machines, PEPS TubeCut removes the need for dry runs. Tubes of any cross sectional shape can be designed in the solid model environment or selected from a range of standard parametrics. Similar or differing tubes can be interpenetrated and the resulting trims automatically extracted.

Brian Warner, Managing Director commented, "TubeCut is an excellent addition to the PEPS product line, either as a stand alone module or in conjunction with our PentaCut 5 Axis CADCAM technology.."

JETCAM Orders Control

JETCAM has announced the replacement of their freeware Mini-PPS product with two new products – JETCAM Orders Control (JOC) Free and JOC Professional. Both products are designed to simplify the creation of orders for single components or component assemblies stored in the JETCAM Expert CADCAM system. JOC Free replaces JETCAM's existing Mini-PPS freeware product, while JOC Professional offers many high-end features

"JETCAM Orders Controller offers users a flexible approach to order management, both in terms of functionality and pricing," commented Ivan Stern, CEO.

Company Profile

Advanced Optical Technology

Profile of a new UK laser company

Advanced Optical Technology Ltd (AOT) was set-up in 1999 by Drs John Ley and Clive Ireland to undertake feasibility studies and customer contracted projects in photonics and to develop new laser-based solutions for key market applications. Of particular interest to the Company were areas that embrace novel concept diode pumped solid-state lasers (DPSSLs) and precision optics as key enabling photonics technologies.

Since formation, the Company has focused on exploiting novel designs of high speed E-O switching, modulating and deflecting devices in new miniature DPSSLs. Their first products line is the ACE range of DPSSL sources, unique in offering TEM_{oo} pulses of ~ 1-2ns duration to ~ 50kW peak power and to 20kHz repetition-rate. These sources are intended for a wide range of high precision micromachining tasks, particularly in the semiconductor and microelectronics areas where use of short pulses results in a cleaner process for material removal. The option of synchronising the pulses with very low jitter to external events means that the lasers also have wide appeal for scientific applications such as time-resolved illumination and ranging and excite and probe type studies, where accurate pulse timing is essential.

The Company strategy includes the development of strong collaborative links with partners offering complimentary technology and market skills, and with key and influential users in target application areas ie those research and commercial organisations benefiting most from photonic based solutions. As part of the strategy, AOT has a very close working relationship with it's sister company Leysop, which pursues a similar business approach but in the optical component and E-O device field.

Current collaborations include one with a specialist crystal developer, Raicol Crystals in Israel, so as to allow AOT to fully develop solutions which maximise the benefits of current and emerging crystalline optical materials used in products.

John Ley, co-founder of AOT, receiving the Smart Award awarded to the company in March 2002

The Company has a strong commitment to product R&D and is committed to maintaining a high level of product enhancement and new product launches, seeing these as essential for sustaining on-going commercial success. Two recent steps in this commitment have been, firstly, the launch of a new ACE laser model that produces subnanosecond pulses (down to 750ps) with the same excellent low jitter as all other models and, secondly, the addition of models in an integrated bench format for non-OEM users. The integrated units operate with only single phase input power (and a TTL trigger signal, if external pulse synchronisation is required for the application).

Both John Ley and Clive Ireland have more than 25yrs experience in the laser and optics industry. John is also the founder of Leysop Ltd, a manufacturer of optical and electro-optic components and subsystems and AOT shares space with Leysop in their new premises at Basildon in Essex.

COMMENT on machine finance *(continued from p17)*

The take up of operating leases has been resisted to a large extent by employing the principle that it is better to "own something" rather than pay a rental and never see anything for it at the end of the day. However, at the end of the day what have you got left? Usually after running the machine every possible hour over three years all that is left, at best, is a machine with very little value or, at worst, a pile of scrap. We have to accept that we are not going to be running the same laser cutting system in ten or twenty years time as is possible with a lathe or milling machine.

When purchasing a machine we usually finance it over three years. This way we hope that in years four and five extra profits can be made once the repayments have ceased. However, maintenance costs will by that time be greater through wear and tear and we also have to face the fact that machine performance is increasing at such a rate that it probably wouldn't be competitive anyway. This would lead us to think that an operating lease would be a good move. One problem would be in the calculation of residual values. The principle looks good and if savings of 30% could be achieved I'm all for it. We'll see.

David Lindsey Laser Process

UK industry requires the most efficient tools in order to remain competitive. The finance method of key and strategic investments of modern technology should be considered as one of these tools.

Whilst representatives of machine tool companies can give basic advice regarding the most cost effective solution to financing requirements, it is increasingly in its own right becoming a specialist subject. I would therefore encourage all companies wishing to explore the various alternatives available to discuss these in detail with a specialist advisor at a face to face meeting. We have seen an increase in the utilisation of operating leases in the last year and expect this to increase in future years. The most suitable way forward can only be arrived at after discussing all the crucial elements of a finance deal covering everything from deposit, period of rental/lease, flexibility, individual company requirements and specific options if applicable at the end of the lease.

Kevin Brien
Pullmax

Laser machine finance: a new dawn?

Steve Gee
Close Asset Finance Ltd
A subsidiary of Close Brothers Group PLC
88 Whitby Road Ellesmere Port Cheshire H65 OAA
T: 0151 356 5472 F: 0151 356 5464 E: sgee@closeasset.co.uk

Traditionally, industrial laser users in the UK have preferred to buy and own their machine tools. However, there are signs that this is beginning to change. Given the rapid advancements in some machine tool technologies, coupled with the need to ensure equipment is kept at the forefront of technology in order to remain competitive, some customers are turning to an operating lease.

A bespoke operating lease solution, such as the one offered by our organisation, requires an initial outlay that is far lower than the traditional 20% or so deposit required on Hire Purchase and the operating lease, often for a period of 3 years, allows full usage of the machine for anything from single to treble shift. With the machine supported by a preventative maintenance agreement, the user can cost jobs accurately, confident that most or all of his machine tool expenses are covered.

Due to the fact the perceived residual value of the machine is taken into account, the monthly rentals, when compared to traditional Hire Purchase or Finance Leasing can be considerably lower. Naturally, this depends on the exact transaction, but savings of up to 30% can be achieved.

Other benefits

Off balance sheet funding:
As a rental-based agreement, the funding liability under the lease would not appear on the balance sheet of the end user as a borrowing. This is especially important for growing businesses, since it means that the gearing is not increased by acquiring often key and expensive assets. It also improves the return on the capital employed achieved by the customer

Tax efficient:
Rentals are normally charged direct to the profit and loss account as a revenue item, in which case they are 100% allowable against taxable profits.

End of lease options:
At the end of the lease agreement the user remains in control and can choose from one of the following:

(i) Returning the machine – probably with a view to updating the asset with the latest model;

(ii) Extending the period of the lease for a mutually agreed period;

(iii) Re-financing the residual value of the machine;

(iv) Purchasing the machine outright.

Overview

Leasing is now the accepted method of acquiring machine tools in the USA and is becoming increasingly popular in the UK. It offers the end user the ability to regularly upgrade their technology and remain competitive by using the most up-to-date equipment available. The lower monthly outgoings mean an increase in overall profit margin, with the customer benefiting from no increase in capital gearing when compared to other forms of finance.

COMMENT on machine finance

As well as benefits to the customer, purchase through an operating lease has its drawbacks too. For example:

- Taken to its extreme, off balance sheet funding could result in a very lightweight balance sheet, offering poor collateral for lenders and increase vulnerability to take over.
- Operating lease terms are often restrictive, or have penalties such as warranty cancellation, or increased charges attached. These terms are usually very strictly enforced.
- Often the 'maintenance' part of an operating lease is charged as an addition to the main rental, and can be a way for the supplier to recoup some margin.
- 24/7 maintenance and support will often be charged as extra, if available at all.
- Specials and customisations would be more difficult to fit into this approach.
- The decision point at the end of 3 years will often result in an increased operating charge by way of an upgrade. If the options of re-finance, purchase or extension are taken up the cost will rapidly match and outweigh the original savings. In addition to this, if users timescales are more like 5 years than 3 years, then the 2 years of zero depreciation would be missed.
- Tax efficiency is a benefit in comparison to a finance lease. Outright purchases attract 25% reducing balance tax allowances (UK). Although not as accelerated an option as the operating lease, the gap is narrower than the article suggests. Additionally any tax breaks that may arise from government budget initiatives can not be taken advantage of.

The question is, why is a finance company prepared to offer an operating lease arrangement? The answer, presumably, is because they are taking a profit from this option. Therefore its always going to cost the laser user more to play this option. The difficulty is that its not always obvious where or when this extra cost arises.

From a laser manufacturer's point of view, whilst we are not averse to selling to leasing agents, our agreement is going to be with the leasing agent not the end customer. As after sales service is so critical in a laser purchase, we feel that this is not always to the benefit of the end user since they have no contractual agreement in place with the laser supplier (unless this is taken out separately).

The laser machine is still a technical piece of equipment and maybe one that as yet is not commoditised to the point of being regularly purchased through leasing agreements.

Tim Adams, Tracey Miah, Simon Wheatley
GSI Lumonics

Continued opposite on p16

Value added for laser job shops

Jay MacFarlane
Laser and Allied Cutting Services
4 Forge Street Welshpool Perth 6106 West Australia
T: +61 89 358 4111 F: +61 89 358 4122 E: laser@iinet.net.au

Over the past few years I have read with alarm the advice from both contributors and editorials within *The Industrial Laser User* relating to diversification to stay profitable in a laser cutting Job Shops. We have read opinions that contain statements such as:

"To provide only laser cutting is no longer a viable business option."

"The one stop shop scenario where the job shop not only profiles but can also bend weld paint and assemble."

"US mission identifies diversification and dissemination challenges for U.K. Job shops."

"The clear trend in laser job shops is to diversify into providing additional metal treatments after laser cutting.".

We presently operate 5 modern laser-cutting machines for 24 hours per day in a well developed, subcontract, profile-cutting market. We service 1400 different customers a year and write 1000 invoices a month. Half of these customers would not spend more than £200 a year with us, but any one of them might be valuable one day, so they are all important. The 100,000+ cutting programs that we have written for our customers are the "goodwill" of the business ready for instant repeat, in the same way that the patterns hanging on the wall insure the repeat business of a foundry.

We have always been touched by the idea of 'value added' and over the past 12 years we have considered extending the use of our lasers by producing our own products. We have designed and manufactured lawn weeding systems, pipe cutters and other hardware items. We designed and patented a solar hot water monitoring device and made a 1000 or so without changing the profit of the business much, bearing in mind the headaches. Then it twigged: there are hundreds of designers out there with great ideas, get to them and sell them a service. Just because you own a laser job shop doesn't mean that you need to become your own customer!

Competing cutting processes

We have always considered installing other cutting processes. Water jet seemed to offer a good solution a few years ago but we are very happy not have stepped in that direction. Water cutting has hardly improved in 10 years, whilst all our problems that water would have solved for us have now been fixed by the remarkable increases in laser machine performance.

Plasma cutting has been considered but was rejected. Fine plasma cutting is slower than laser whilst heavy plate cutting would require a complete change to our material handling and storage systems. Another important consideration was the difficulty of maintaining two sets of tolerance criteria in one shop.

Metal punching systems have been thought about but really this another complete trade. The real reason, perhaps, for our non-involvement is that both punches and gas cutting earn about half that of a laser with about the same running costs.

Concentrating on the core business

Over the past few years we have been well rewarded by our policy of developing and expanding our core product, and this has become our only ambition. For us to undertake bending, welding etc would be economic suicide.

We have a sheet metal customer next door and if required we try to channel work to them with very little result. We see that our place is to support and help every one of our metal working customers and it would be crazy to try and compete with them. In the early days of our business, incoming customers would cut the bottom off their drawings to prevent us knowing who the job was for, fearful that we would attempt to short their work and undercut them. The trust is such today that we have not seen a 'cut' drawing in years. When delivery times get tight there can be no suggestion that we run our on work first. We stand as a true subcontractor: in our eyes, all customers are equal without fear or favour.

We are, however, in a similar position to many job shops in that there is competition from half a dozen other laser cutting companies in the town. Prices for cutting has not increased for 10 years, but wages, consumables and everything else has increased, sometimes doubled. Profit margins have been eroded and efficiency gains from multi-machine operation and super-fast processing from modern machinery have not really been enough to compensate. We needed to look to something extra to maintain our edged.

Focusing on materials costs

A casual review of our accounts has shown that over the past 5 years our business has changed. Our net profit (before interest, tax and depreciation) has fallen from 34% of sales to 24%. An encouraging trend shows that wages has dropped from 30% to 25%, and gross sales have increase by 68% over the same period. Now comes the serious bit, sales of materials are up 277%.

We make no profit from the sales of steel and other materials. On the surface of it our estimators add 20% to the cost of steel when quoting a job, yet at the end of the year we sometimes show a loss. Where does it all go? 20% in the scrap bin maybe! Unlikely, but

Macfarlane's law of laser cutting (1992)

For materials more than 2mm thick:

- The cost of laser cutting is doubled as the material thickness doubles.
- The quality of laser cut edges is halved as the material thickness doubles.

Example: cutting 12mm is 4 times the price of 3 and the cut quality has reduced considerably

we are slack on off-cut control. We all know that to spend a minute saving 1sq ft of 3 mm mild steel is dead time, in 12mm the argument is different. Of course, Isaac Leverdick (December 2001 issue of this magazine) would use the same argument for the "shiny stuff" (12mm stainless)!

One of the problems we face is that we never really know what a steel company is going to charge: pallet fees, delivery fees, invoice fees and cutting charges can double the listed price of a sheet of metal. Steel companies will sell to most of our customers at the same price that we buy, whilst our bigger customers can buy cheaper than we can.

It is often difficult to add much of a margin when quoting work. For us to return to a condition where all of our customers supply, would make a chaotic stock control situation, so it is easier for us to supply even at no profit. We have accepted a situation where we turn over £1M a year in stock for no gain!

When we re-examine our accounts and discount the effect of the enormous increase in steel purchases, we find that over the past 5 years actual profitable work has only increased by 45%, net profit has really only reduced from 34% to 28% and our wages have remained static at 30% of adjusted sales. (We have 12 years of comparison accounts to assess the progress of our business, but you can only get value from this history by comparing apples with apples.)

"We have (in the past) accepted a situation where we turn over £1M a year in stock for no gain . . . . . . so we have decided to buy our steel in bulk."

Faced with the challenge of increasing the return to our shareholders whilst meeting increased competition in pricing, we have decided to buy our steel in bulk. Despite the fact that our merchants cannot find a retail or wholesale pricing structure for us, our decision is prompted by more than just money.

Steel supply

We have long put up with poor service from our steel suppliers. Rusty metal, scratched surfaces, late deliveries are just the beginning. Grade 250 steel can be manufactured by two different processes, the plate mill produces in sheets around 2 m x 8 m in thickness increasing from 5 mm, whilst the hot strip mill produces to 12 mm thick in coil form. Where we come from, the plate steel is shipped across a continent in uncovered wagons and stored in open sided warehouses near the sea. Consequently, the mill scale on plate is augmented by rust, making for a laser cutting nightmare, and those who manufacture and sell steel just don't seem to care.

Ha250 steel ex-coil is the best for laser cutting steel, low in silicon and with little mill scale, it cuts and finishes well in paint without sand blasting and it will take a bright finish when galvanised. Unfortunately none of our steel merchants are capable of reliably unrolling steel above 6 mm. Badly unrolled sheet from outdated rollers encourage flat profiled parts to curl back into their coiled memory as soon as we relieve the surrounding metal. So we have had to revert to rusty steel plate for thicker profiling. We hope few of our readers have had to put with nonsense like this. However, Western Australia is an agricultural and mining state with few serious large manufacturing companies, which is really a benefit as it translates into a good laser-cutting climate with many small scale manufacturers dependent on low volume processes.

By joining forces with a nearby steel processing company we have together managed to place an order big enough for a mill to notice us. On our side we have ordered our first 300 tons of low carbon, low silicone steel from Japan in 8 different thickness' and we expect to repeat this order 4 times a year. The steel will be unrolled and cut to size at the mill with effective rollers capable of removing memory, and supplied wrapped on pallets 1500 x 3000 mm. We have built a new 750 m² factory and arranged (by copy of this article) an additional extension of overdraft of £100,000 to cover the extra stock.

Extra rent will cost £10,000 per year, interest perhaps another £6,000. Assuming that we will only bulk purchase, half of our annual material requirements, the savings (approx. 22%) on steel purchases should translate into £100,000 increase in the all important bottom line. We will also decrease the load on our purchasing department, avoid downtime on slow deliveries and, of course, we will gain from increased cutting speed in good steel.

We have to be fearful of a deterioration in service from local metal sources (I would not print this article in a local magazine!), but we still have a large budget to spend in the town for grade 350 steels, stainless, high tensile, and oversize sheet and that should keep them on their toes. We have no intention of becoming a steel merchant at this time, only importing for our own cutting use.

We have always had to regard steel companies as competition as they all offer plasma or oxy-cutting services. At times we have found them offering cut steel parts to our customers cheaper than they will sell the sheet to us to cut the parts from! We are now able to compete with them if necessary, on a much more level playing field. All this planning seems so much more logical than competing with your own customers.

The lovely thing about being a subcontract laser cutter is that we have never had to finish a single job! I am determined to keep it this way. Meanwhile we look forward to unpacking our first shipment.

Jay Macfarlane was born in England. A Master Mariner by profession, he moved to Australia in 1970 and opened a Yacht factory. After saturating a market with 15,000 small sailing boats another career change was required. CAD CAM systems were a part of yacht manufacture, so in 1989 a small "one horse" laser job came up for sale and it was an easy choice. With an excellent management team in place, Jay now restricts his work to laser machine maintenance and business software development. Today he spends more time sailing boats than he ever did when running a yacht factory!

More disjointed jottings

Competitive Advantage

Peter Charnley

RE Cooke & Son (Burton) Ltd

What a year 2001 was! With continuing contractions in manufacturing employment, is it only me who wonders whether or not we're going to reach a point, sooner or later, when we can no longer support a manufacturing base? I hear that another 200,000 jobs were lost in manufacturing last year, and that this trend is likely to be maintained in 2002. The distortions in the economy were exemplified by the so-called dot-com revolution in the late nineties. It was unnerving that so many city types really believed that this was the way forward; but with this blinkered mind-set, is it any wonder that these people can't see that UK manufacturing is where investment money is needed?

Coupled with all of this, UK plc is operating within a world economy that is looking fragile. The electronics and telecommunications markets are still down-sizing, which has an impact on a number of our members. Oil prices are doing strange things, driven by that wretched cartel, and the prospect of military action post 11th September may yet result in shortages. We could do without that on top of everything else!

All of these sets of economic circumstances set the scene for continued pressure on margins. Our customers' know that it's a buyer's market, and they are using this to leverage prices down. An example of just how quickly some buyers can default to type came my way a month or two ago. One of my customers had preached the gospel of "partnership" and "inclusive" working for several years. He made a point of letting me know that he would never buy on price alone, and that the "bigger picture" was what he looked at. All very enlightened, but imagine my surprise when he told me that we had been unsuccessful in securing a significant piece of work last autumn, because he'd found someone cheaper. Where was his "partnership" view of our relationship, I asked. He told me that for the foreseeable future, he'd now be buying at the lowest prices, and looked very sheepish indeed.

I cannot be complacent about any of this, but I have sufficient confidence in my selling capabilities, my managing director and the team that is R E Cooke & Son, to feel bullish about 2002. We've invested in new plant, and I have set myself a sales and profit target for the year that will keep me occupied, that's for sure! I have always contended that a professional selling team can buck the trend, and bring work in at the right prices.

But for all my years in selling, I am still vulnerable if I have insufficient information to allow me to negotiate on equal terms with a buyer. A few weeks before the end of 2001, I was called in by one of my bigger customers. (No names, but I bet that most of us have supplied them at one time or another). I had recently been instructed to fill in a cost-justification sheet, breaking down our selling prices into machine overheads, transport, etc., and, finally, profit. My laser overhead rate was, I was told, far too high; I was instructed to reduce it down to "market levels" or else risk losing most of their work.

One of the weaknesses of our industry is that we operate in separate cells and don't network as much as I'd like; and to be honest, I couldn't say with certainty to this buyer that my laser overhead was industry-typical. I felt exposed, and needed all my skills to hold the line. What I did next was what I would like to think any of us would have done: I phoned around members' and sought confirmation of what the typical industry overhead was on the sort of machines that I was using. Armed with this information, I was able to go back to the buyer, and came away without having to move on price.

Don't get me wrong, I did nothing that was against any of the current restrictive practices legislation, but I think that we need to be capable of seeing the bigger picture. If we can help one another in ways that give us confidence to, say, not reduce prices, this must be good for all of us because the market prices are not being unduly eroded. We all benefit.

May I be selective and address a question to those Job Shop members who are reading this article today: Why did you choose to join AILU? I wish that this was a live forum, because I'd welcome the necessary feedback with which to develop my thesis, but I'm fairly certain that each person would give an answer which came down to maintaining a competitive advantage.

By competitive advantage I mean the (positive) difference that differentiates one's organisation from its competitors', giving it the edge in the market place. These differences range from the obvious to the subtle, including:

- New, state of the art machinery
- First class production people
- First class commercial people
- First-class sales people
- Own transport fleet
- "Right first time" quality culture
- Profitable, and diverse customer portfolio
- Capital investment plans
- Focused business strategy
- Market knowledge and competitor information

My bet is that everyone's initial thought process about joining AILU included the need to be a member of a trade grouping that might add to one's own knowledge and commercial capability. In addition, almost certainly, consideration would have been given to the need to ensure that you had exposure to the same nuggets as your competitors', so that they didn't gain advantage over you. (The good old self-preservation motive!)

If these were your motivations, have your expectations been met? From the limited contact that I have had with other members, I believe that there is a bit of a shortfall. Don't get me wrong, AILU is seen in a positive light, and the fact that our membership is increasing speaks volumes. But could Job Shop members be more satisfied, and could we have an even greater membership?

Earlier in 2001, I wrote that my concern was that AILU was seen as having an orientation towards research work, which had no immediate relevance to the Job Shop environment. That was my own personal view, of course, but I received no comment expressing a contrary view. Since then I have had the opportunity to get to know a little more of the Job Shop Committee and its hard work in promoting the interests of Job Shop members.

Let me get back to my theme of a trade association, and our individual motivations for joining AILU in the first place. If my experience is anything to go by, the only way that real benefit is to be got out of our group, is through the recognition that we have to exchange information. If we all single-mindedly avoid sharing anything for fear of giving our competitors' an unnecessary advantage, then how can we expect to benefit ourselves? Collectively we can influence the market, not as a cartel, but through a better understanding of what's going on in our industry. There's a sort of synergy at work here, and my contention is that we can all benefit from playing a more active roll.

Numerically the response to Job Shop questionnaires is quite low. This gives rise to questions of statistical validity, due to very small numbers, which makes the data suspect at best. This can become a vicious circle, with even more indifference to completing future data collection requests, because the results are "always" dubious! My concern is that we have a core of members who are cynical about form-filling, and I wonder if they see AILU cynically too. My vision: An active, participative Job Shop membership, operating (legally) in a way that, over time, will raise the standards of our industry.

OK, this is contentious stuff, and I need to be rather more precise in what I'm getting at. In summary, I believe that all of us have a wish to ensure that our respective businesses benefit in some positive way through membership of AILU. The framework of a good trade association is the vital statistics of the industry that it represents, and these items of data are collated from the membership. The data has to be from 100% of the membership to be relevant; and the questions need to be seen as meaningful by the membership in the first place.

If questionnaires and data collection forms are phrased appropriately, we might gain useful insights into our industry and its markets, including:

1. Size of market sectors (You can work out your market share)
2 Which sectors are growing or reducing (You can focus sales efforts)
3 Average overhead rates (You can review your pricing strategies)
4 Whether or not our industry is growing or reducing. (You can plan your sales strategies)
5 Other relevant facts & figures yet to be agreed, but you will follow my drift! (All of this is "big picture" stuff at the moment.)

Before anything like this could work, you would need to have absolute certainty in the confidentiality of the framework operating, and that your figures would become utterly anonymous in a mass of other data, and presented as either a statistical trend or aggregate totals. These are "givens", and would need to be addressed. But if all the necessary actions were taken by AILU, would the sorts of statistical data proposed help in achieving competitive advantage? And is it possible that we could improve the standing of our industry overall in the process? (My thinking is that a coherent, market-aware industry will be better placed to succeed in an increasingly complex business environment.)

The next step is to get some feedback to these suggestions and proposals, and on the basis of that feedback, to act accordingly. Subject to approval from AILU and the Job Shop Committee, I hope that I can be in touch later in the year, to move things forward. In between times, if anyone wants to make any observations directly, my e-mail address is *peter.charnley@recooke.co.uk*

Some web sites and e-mail groups worth a visit

Eulasnet

http://www.bit.ac.at/eulasnet/

The web site of Eulasnet, the EUropean Laser ApplicationS NETwork, lists the current laser-related EUREKA!projects and facilitates potential partners in these collaborative activities to identify suitable projects.

ePatents

info@patentweb.de (to subscribe, send an e-mail message with the word "subscribe" in the message)

ePatents is a free email newsletter designed to bring the latest US laser materials processing patents. The service is provided by the Patent and Literature Search Service, Munich.

Laser Processing Discussion Group

laserprocessing@yahoogroups.com (to subscribe, send an e-mail message with the word "subscribe" in the message)

A Laser Processing Discussion Group launched by Siva Wignarajah of Taisei Corp., Japan, 'to provide a platform for open discussion on laser processing and to provide free information on laser materials processing technologies including latest research and development results, sources of supplies and services and solutions.' Though not particularly active, some of the corresponence is interesting.

Laser questions answered

http://www. laserfaq.com

Sam's Laser FAQ, described as 'A Practical Guide to Lasers for Experimenters and Hobbyists' is probably the best web resource of its kind. It is essentially a collection of documents containing a great deal of practical information on a variety of laser related topics. It is particularly useful for basic laser principles and general information, including lists of discussion and newsgroups, and many references and links and visitors can submit their own questions.

Journal of Laser Applications

http://www.laserinstitute.org/jla/

Published by the Laser Institute of America, the Journal of Laser Applications is now available online. The online version at is viewable free-of-charge during 2002. Afterwards a subscription fee must be paid.

Optics.org

http://optics.org.uk

A heavily commercial site but an excellent source of international laser news. Visitors can subscribe to the free weekly newsletter.

What are your favourite web sites? Send your offerings to *mike@ailu.org.uk* so that we can share them with other members.

Upgrading your quality system to ISO 9001:2000

John Powell[1] and Tony Brearley[2]

[1] Laser Expertise Ltd
Acorn Park Industrial Estate Harrimans Lane Dunkirk Nottingham NG7 2TR
T: 0115 9851273 F: 0115 9851276 E: j.powell@laserexp.co.uk

[2] AB Quality Consultants
32 Warwick Avenue Quorn Leicester LE12 8HD
T: 01509 556775 E: abquality@ntlworld.com

John Powell

Let me start by offering the reader some straightforward advice - upgrading your quality system is almost certainly going to require the help of a consultant. This is not because the requirements of the new system are complicated, it's because they are sometimes rather vague and difficult to clarify. It is rumoured that BSI are having difficulties training up their inspectors and it is certainly true that there is plenty of room for confusion and error.

BSI have changed the quality standard in order for it to be applicable to a wider range of companies - from insurance claim investigators to dentists. Some of the changes are simply in the wording. For example:

'Customer complaints' are now referred to as 'customer feedback'. 'Free issue product' is now referred to as 'customer property

There are a few similar changes.

Going back to the vague and/or unclear parts:

7.2.1.b 'The organisation shall determine requirements not stated by the customer but necessary for specified or intended use, where known.'

8.5.3 'The organisation shall determine action to eliminate the causes of potential non conformity in order to prevent their occurrence.'

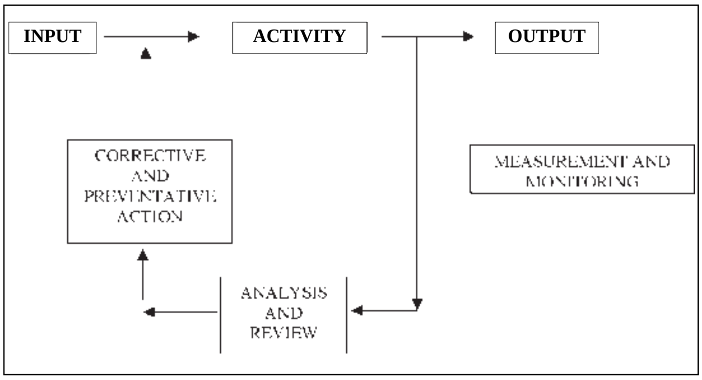
6.1.b 'The organisation shall determine and provide the resources needed to enhance customer satisfaction by meeting customer requirements.'

As you can see, from a laser jobshop point-of-view, descriptions of these three extracts range from ‘odd’ (7.2.1.b) to ‘very ambitious’ (8.5.3) to ‘totally obvious’ (6.1.b) and in all cases it is not clear how to incorporate them as requirements into a formal system.

After reading through the new standard I found that about three quarters of it made sense and the rest of it made me lose the will to live. Eventually I brought in my quality consultant and I leave you in his capable hands.

Tony Brearley

ISO 9001: 1994 was structured around manufactured items and comprised 20 clauses which fitted comfortably into a manufacturing operation. The new standard ISO 9001: 2000 is set out in five sections in order for it to be applied more easily to any type of organisation, ie:



Flowchart showing the various stages in the quality system embodied in ISO 9001:2000.

- Quality Management System
- Management Responsibility
- Resource Management
- Product Realisation
- Measurement, Analysis and Improvement

The new standard specifies requirements for a 'Quality Management System' as opposed to specifying 'Quality System Requirement’.'

The requirement is now for a management system that is based on the concept of continual improvement and focuses on customer's needs and expectations. The system is embodied in the management principles of:

- Customer focus
- Leadership
- Involvement of people
- Process approach
- System approach to management
- Continual improvement
- Factual approach to decision-making
- Mutually beneficial supplier relationships.

The most radical change is the move to a 'process model'. A process may be defined as a series of activities, which converts inputs to outputs, as illustrated on the flowchart above.

The bodies involved in the process are referred to as

SUPPLIER ORGANISATION CUSTOMER

There is more emphasis on the following:

- Top management to be committed to developing, implementing and continually improving the Quality Management System.
- Quality objectives and ensuring that resources needed to achieve such objectives (human, physical and environmental) are identified, quantified and planned.
- Identifying the need for improvement and promoting awareness of customer requirements.
- Evaluating training to determine whether, as a result, the employee has become competent in the task.

John Powell:

We now have our new system in place and the actual changes to our working life are few. Although the new systems calls for a lot more checks and measures of quality performance, we were doing these anyway. For example, information from our sales and admin meetings is now incorporated into the quality system. This is to satisfy such requirements as the quantification of the overall performance of the firm. Such measures as debtor days, absenteeism and (most importantly) profit have, of course, always been closely monitored but the trends and results are now part of the quality system.

In brief, although I don't like the gobbledegook in some of the standard, your quality system, once it has been updated, will give you a more comprehensive view of the performance of your firm.

COMMENT

Why bother with ISO9000?

Almost every company commits to ‘quality’ but sometimes it seems difficult to find out exactly what it is that top management are committed to. ISO 9001:1994 provided a basis for a formalised procedural quality system, which enables a start to be made to defining that commitment. Too many times have I seen large amounts of money spent introducing ’quality’ oriented techniques only to find that impetus and improvement withers and virtually dies due to the lack of a sound foundation on which to build.

As the article by John Powell and Tony Brearley explains, the change of focus in ISO 9001:2000 moves from a procedurally oriented approach to a more general process-focused model. In so doing, it reflects the current move in quality management systems to adopt the principles established in modern business excellence models.

The change from procedure to process is not easy to get to grips with. A procedure is clearly necessary when tasks need to be performed consistently and is designed with the person carrying it out in mind, whereas a process converts an input into an output and is designed with the user of the output (the customer) in mind.

As processes occur in all activities, ISO 9001:2000 can be applied to a great range of commercial activities. Processes have objectives with related quantitative and qualitative measures and as such a ‘plan-do-check-act’ improvement cycle can be implemented that does not recognise departmental or functional boundaries.

To move from managing procedures to processes you need to:

- Clearly define objectives and how they will be measured to review success;
- Evaluate the impact of these objectives on everybody, customers, suppliers and all other process participants;
- Design critical end-to-end processes necessary to delivery of the objectives;
- Assess and provide the resources, skills and competence to make the process work.

ISO9001:2000 has the potential to give the management foundation for improving customer satisfaction and profit. Key to all this is an unwavering and active commitment by top management to customer satisfaction and continual improvement. Sadly, it appears that ‘quality’ is not self-sustaining - it requires constant work. The emphasis in ISO9001:2000 on both processes and improvement programmes provides the drive for that continual attention.

Mike Barrett Pro Laser Consultants

Is ISO 9000 really management in disguise?

Ask yourself these questions:

- How much money have you invested in training over the last 12 months? Did the employees that received the benefit of that training work any better or add more value to the business?
- How much money have you invested in new equipment and computer systems? Have they lived up to the intended ROI? Have they improved your overall quality?
- Did the modern management techniques such as “Kaisen”, “The 5 S’s” or “Multi-functional work teams” that promised so much really deliver?
- Has your expensive Quality manual been read and understood by your employees (other than the Quality Manager)?

If your answer to at least one of these questions is “no”, your company has a management problem.

This is why the new ISO standard has hit the mark perfectly; it mentions the words “responsibility” and “process owners”. Couple this with properly defined job descriptions, performance targets, and a robust company disciplinary procedure and you have all the management tools you need to make a difference.

We have just been accredited to the new standard and, unlike when we obtained Investors in People status, and unlike the endless rounds of Continuous Improvement initiatives, I can see and feel positive change happening.

The new ISO standard is about culture change. Instead of basing your quality system on a heavy, dusty, unused manual, the new system is visual, relevant, and usable. The change from procedure to process is difficult to grasp initially. I found the most important difference between the two to be the question - why? If people are used to following a written procedure (or, let’s face it, their interpretation of it), they rarely question why they’re doing it. The new process-based system makes it simple to identify activities in a process, and thereafter question why each is being done. But is the activity adding value to the process, and are the people responsible for the activity doing their jobs?

As an example, after mapping our processes clearly, and ensuring process ownership, we carried out an analysis of the Engineering / programming function. 40% of activities were found to be non-value adding. We now have two fewer engineers, and output has improved. We are expecting similar results in our fourteen other key processes – and that’s competitive change!

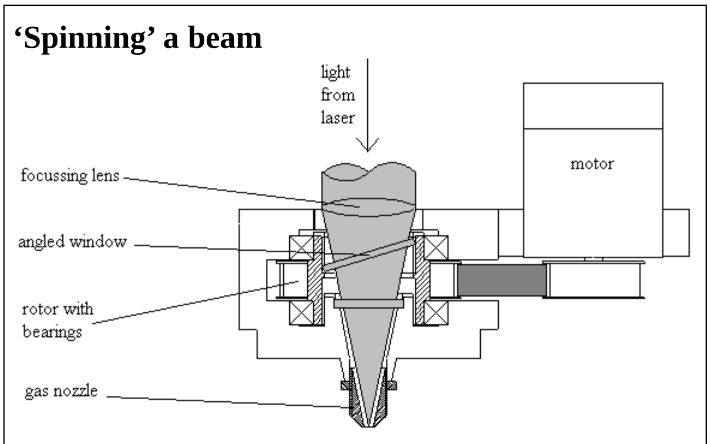
Martin Cook NG Bailey Manufacturing

Thick Mild Steel Plate Cutting with a Spinning Nd:YAG Laser Beam

James Harris and Milan Brandt
Industrial Research Institute Swinburne (IRIS)
Swinburne University of Technology P.O Box 218 Hawthorn Melbourne Victoria 3122 Australia
T: +61 3 9214 5082 F: +61 3 9214 5050 E: jharris@swin.edu.au

The commercial laser cutting of mild steel plate up to 15 mm thick using high power CO_2 lasers is now a well established process. However, there is industrial interest and demand to use lasers to cut plate up to 50 mm thick. One solution is to use higher power cutting lasers, with all the challenges this raises regarding stability of beam quality, reduced lifetime of the optical components, higher equipment and running costs and deteriorating cutting precision. An alternative for cutting thick plate involves 'spinning' the beam. The preliminary results presented here involve use of a 'spinning' 2.5 kW fibre-delivered Nd:YAG laser beam to cut mild steel plate up to 20 mm thick. They raise interesting questions about the dynamics of the laser cutting process.

The feasibility of spinning beam processing was first demonstrated in work at TWI near Cambridge, with first reports in 1985 for laser welding and in 1994 for laser cutting. At relatively low CO_2 laser power, 25 mm thick mild and stainless steel plate could be cut with acceptable quality but little information was presented about the mechanisms responsible for the performance at increased thickness. Figure 1 illustrates the basic principle of using a rotating wedge to 'spin the beam, as used in the work presented here.



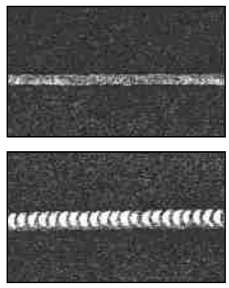


Figure 1 Spinning Beam cutting apparatus
An optical flat placed below the focusing lens is angled to produce a sideways displacement of the focal position. Rotating the optical flat causes the focal spot to describe a circular path.
As the focusing head is moved over the workpiece the path becomes a spiral, as is illustrated (right) by the scribed path of a 200W Nd:YAG beam travelling left to right on a mild steel plate. (upper) a conventional (non-spinning) beam and (lower) spinning beam.

Preliminary trials

Results of cutting speed vs. plate thickness are shown in figure 2, which compares the results of conventional cutting and spinning beam cutting for various incident laser powers. Conventional laser cutting was limited to thickness of 12 mm but the cutting trials results demonstrate that with the spinning laser beam apparatus an increase in cut plate thickness to 15 mm can be achieved. Attempts at cutting the 20 mm plate were partially successful, but as the cut depth was increased, excessive dross accumulated at the base of the kerf and there was excessive burning of the sides.

Figure 2 also illustrates a continuity of the conventional cutting curve into the spinning beam regime i.e. for a given laser power, a single characteristic curve can approximately describe both processes, although in addition to the improvement in cut depth there is also a modest increase in the cut speed with the spinning beam.

The effect of spinning the beam on the kerf width and shape is shown in Figure 3. The spinning beam produces a far larger kerf resulting in a larger volume of material being removed and a larger amount of oxygen entering the base of the cut. Despite this, the same approximate limitations to speed of cut (but not depth of cut) are found to hold.

There is an optimum spin speed for best cut quality, depending on material thickness. For 10 mm thick mild steel plate the optimum was at 3000 RPM, dropping to 2000 RPM for 12mm and 15mm thick plate. 2000 RPM was chosen as the most appropriate spin speed for cutting trials with 12mm thick plate. 2500 RPM was noted to only yield a slight decline in quality, while reducing the spin speed below the optimum rapidly resulted in the formation of dross on the lower cut edge. This phenomena was observed for all four plate thickness tested.

Analysis of Cut Results

The cutting of thick mild steel plate using a spinning laser beam demonstrates similar characteristics to those observed under con-

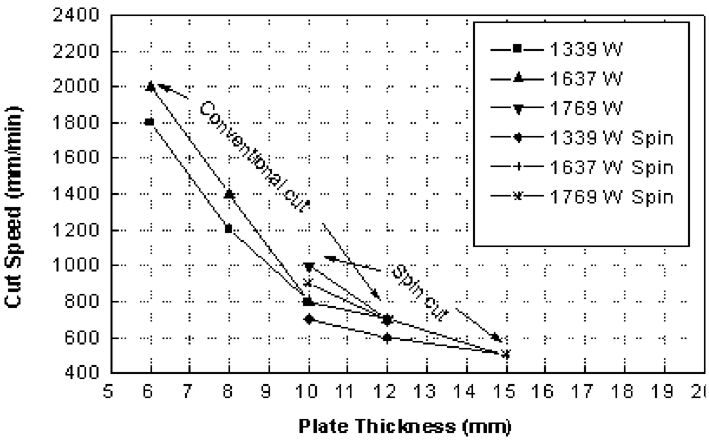


Figure 2. Cut speed as a function of mild steel plate thickness using conventional and spinning beam cutting.

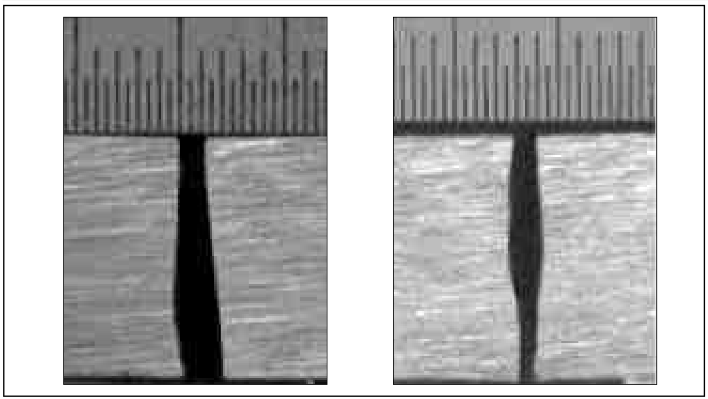


Figure 3. Comparison of kerf shape for (left) spinning and (right) conventional laser cut.
When cutting 12 mm mild steel plate at 700 mm/min with 1488W incident on the workpiece , the average kerf width of 1.2 mm was found for conventional cutting and 2.5 mm for the spinning beam. In addition to being wider, the spinning beam kerf is non-symmetric, a result of the fact that the relative velocity of the beam and the workpiece is different on the two sides of the cut.(i.e. the rotational velocity of the beam adds to the translational velocity of the workpiece on one side of the cut and subtracts from it on the other).

ventional cutting. as shown in Figure 4. It also appears that spinning beam cutting offers a wider operating window for high quality cuts.

It should be noted that the parameters set for cutting of mild steel with the spinning-beam apparatus are not the same as those used for conventional cuts. Spinning beam uses larger nozzle diameters and lower oxygen pressures. Further, when the spinning beam is stationary there is poor nozzle/beam alignment, which is a crucial cut quality parameter.

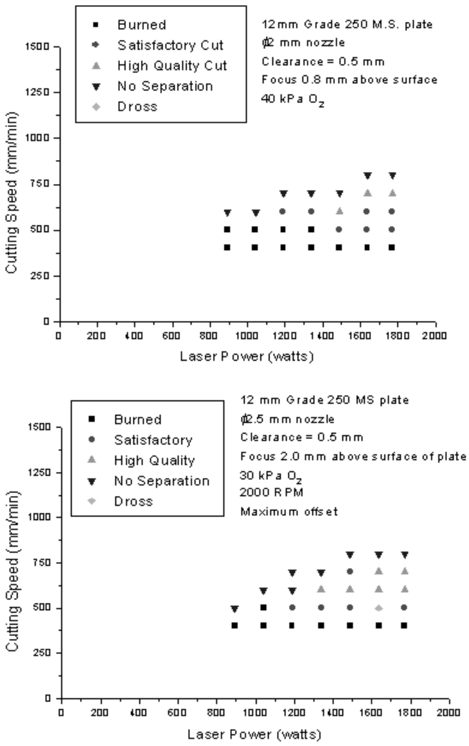


Figure 4. Comparison of optimised cut results for 12mm thickness AS1204 grade 250 mild steel plate using (upper) conventional cutting and (lower) spinning beam cutting.

Conclusions

Spinning-beam cutting has been showed to provide a significant increase in the depth of cut over the range of thickness investigated, yet analysis of the coupling of incident laser energy into the plate (see figure 5) indicates no significant improvement for spinning-beam cutting, neither has any significant enhancement in cut speed been observed.

One observed difference between the two cases is that the ratio of oxygen available in the kerf to metal removed is somewhat greater for spinning-beam cutting. However, whilst current investigations are incomplete, they indicate that the exothermic oxidation reaction that occurs during oxygen-assisted laser cutting is relatively unchanged despite the fact that the increased kerf width of spinning-beam cutting results in a greater amount of material removed and an increase in oxygen flow into the cut.

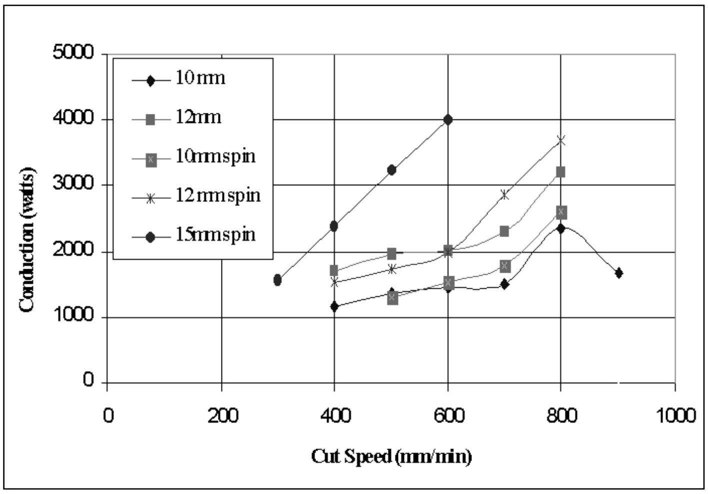


Figure 5. Conduction as a function of cut speed for conventional and spinning-beam cutting.
The calorimetric analysis, similar to that performed by A. Ivarson (Doctorial Thesis (1993) "On the Physics and Chemical Thermodynamics of Laser Cutting", Lulea University of Technology).
The results show that a similar amount of heat is conducted to the workpiece in both conventional and spinning-beam cutting, implying no difference in the thermal processes taking place within the cut.

The improved depth of cut produced by spinning the beam may be a result of an improvement in gas purity within the cut for, in this case, material thickness greater than 12mm. i.e. the wider kerf obtained by the spinning beam, especially at the base of the cut, resulting in an improvement in oxygen purity in this region, allowing cutting of thicker material.

Another difference between conventional and spinning-beam laser cutting was revealed in a microscopic inspection of dross. This revealed that spinning-beam cutting produces much less well-formed spheres; perhaps the result of more turbulent conditions within the cut caused by steps created along the cut face as, during cutting, the melt front moves laterally across it as well as down. However, modelling of the gas flow within the cut kerf and analysis of dross samples are as yet incomplete.

This article is based on a paper presented at the ICALEO 2001 (Jacksonville, FL, USA 15-18 October 2001) and is published by permission of the authors and the Laser Institute of America. Full Conference Proceedings on CD are available from the AILU office.

COMMENT: Cutting with a spinning laser beam

As referenced by the authors, the beam spinning technique was first developed by Chris Dawes at TWI, for laser welding of sheet steel. In that work the goal was to produce a slightly wider weld than that obtainable using just a simple focussed spot, in order to compensate for poor edge quality. The same technique was used in the Eureka Project EU194 for cutting thick steel. Using this technique to generate a 2mm wide kerf width, C-Mn steels up to 30mm thick could be cut with reasonable edge quality at speeds of about 0.1m/min.

A few years ago on a visit to Amada in Japan, I was shown a new beam spinning cutting nozzle which they were about to commercialise on their flat bed CO_2 cutting systems. The device used the same principle as that described by Harris and Brandt but was targeted at the particular market of stainless steel cutting (up to 15mm thick if I remember correctly). Amada felt that the beam spinning technique not only provided advantages at these thickness' for the cutting of stainless steel, but also for the pierce through, which was a lot quicker and cleaner than that obtained using conventional techniques. The test pieces I were shown, stainless plates 1m x 1m, completely covered in 20mm diameter holes, were testament to the efficacy of the beam spinning technique.

Paul Hilton
Laser & Sheet Processes Group, TWI Ltd

Beam spinning is a promising technique for optimising thick plate cutting in some special applications. In particular, the combination of adaptive beam shaping and beam modulation can offer new possibilities. James Harris and Milan Brandt have taken up this topic and have presented some interesting new results.

The influence of spinning parameters (amplitude, frequency) is worthy of a more detailed investigation, but I feel that the next step that should be taken is to compare the spinning results with cutting using the same laser power and simply a longer focal length focusing lens, one that gives the same kerf width as the spinning beam, though of course the local intensity will be lower. This study could reveal important information about the main advantage of the spinning beam. Is it the wider interaction zone, a wider kerf width improving the depth of oxygen penetration into the kerf, or is the modulation resulting from the rotation of the beam producing improvements in the melt and reaction dynamics?

Whatever the answer, James and Milan have restarted a fascinating approach to gain new insight into laser beam cutting.

Dirk Petring
Fraunhofer Institut für Lasertechnic (ILT)

Although there is no direct application for spinning beam cutting (at the moment), this type of research is necessary if laser cutting is to be fully understood and utilised in the future. Techniques for widening the beam at the cut front (as spinning does) might be the key for thick section cutting in the future. I look forward to Jim and Milans further work with interest

John Powell
Laser Expertise

? QUESTION AND ANSWER

Two-tier pricing of laser sources

Laser OEMs have two prices for their lasers, an OEM price and a list price. What is the justification of a two-tier pricing structure and how well established is this practice?

In the context of the question, an OEM is a company that buys lasers for integration into its own machines by its own staff and which then takes responsibility for the complete installation and commissioning of the lasers. During the warranty period the OEM provides free labour by suitably trained engineers for any servicing that is required, and for training of the end-user's personnel.

Experienced systems integrators have a high level of understanding of the factors that determine the success of an integration and of an application. Good work on their part reflects credit on both themselves and the source manufacturer; this also is acknowledged in the OEM discount, if the OEM is willing to publicise his use of the source. Part of the deal with the OEM may also involve an obligation to collect data on the service performance of the source and to report it to the laser manufacturer.

Many products are designed and built specifically with an OEM integrator in mind i.e. built to a lower level of integration for incorporation into purpose-designed machines with laser safety devices etc. built in. On the other hand, an end-user-integrator (i.e. one who pays list price) normally buys only one laser, wants the laser manufacturer's engineers to install and commission the laser (though usually at an additional cost) and look after the warranty. The supplier is usually involved in more technical discussion and needs to provide a much higher level of technical support throughout the project. This could reflect uncertainties in the specification of the laser and its options, process optimisation and essential process aids (e.g. shield gas nozzles, process feedback detectors), and lack of knowledge of the technical, safety and regulatory aspects of laser integration.

OEM sales are common for many types of products. All stores distributing consumer products purchase the product on a similar basis as an OEM deal. If you look at the cost of the 'extras' that the non-OEM customer is getting and the benefits for the laser source manufacturer in selling to an OEM, including the potential quantity of sales in a given time and transfer of the warranty for the product, it should be clear why there is a premium for a non-OEM sale, depending on what the laser type is, where the customer is in relation to the sales office etc.

If the 'list' customer really wants to have the laser at the OEM price, ask him if he will (a) guarantee to buy at least 10 off per year, (b) integrate them himself, (c) cover warranty costs, (d) service the lasers, (e)......

This answer was composed by mixing and matching various individual contributions from a number of major laser source and system builders and consultants whom we asked for a response. All respondents agreed on the basis for the two-tier pricing structure, but each had his particular emphasis, so the answer should not be understood as necessarily representing a common position.

The respondents were: **Kevin Brien** (Pullmax), **David Foulkes** (Trumpf), **Keith Hilliard** (Coherent UK), **Tim Holt** (Institute of Photonics), **Tim Weedon** (Consultant)

Laminated Tool Manufacturing by Laser Cutting and Diffusion Bonding

Sabine Saendig*, Thomas Leutbecher and Peter Wiesner
Faculty of Mechanical Engineering, Technical University of Ilmenau
Ilmenau Germany
*T: +49 3677 670 439 F: +44 3677 691 660 E: sabine.saendig@tu-ilmenau.de

The combined use of CAD, modern simulation techniques, Rapid Prototyping (RP) and Rapid Tooling (RT) enables the product development process to be shortened considerably. At present, parts manufactured by RP methods are generally made from polymeric materials or metal alloys. Here we present an alternative method for manufacturing fully functional metallic parts as well as tool inserts from sheet metal in a short time. The technique involves the laser cutting of metal sheets and the subsequent consolidation of elements to form the component by diffusion bonding of the sheets over their entire contact surface without the addition of any other material. Such moulds and dies are shown to be capable of being employed for mass production and often to offer a better performance than traditional tools.

Laser-assisted techniques of Rapid Tooling

At present, the powder-processing methods such as laser generating or laser sintering enables simple functional parts and tool inserts to be made in metal. The disadvantages of these methods are that the material is often not suitable for mass production, the mechanical properties are insufficient, the parts may distort and surface quality is poor. For these reason, they have not been fully accepted in the field of tool and die-manufacture. An alternative technique is 'Laminated Object Manufacturing' in which sheets are cut out of the desired material and held together by screwing, clamping, bonding or welding. With these techniques it is not possible to manufacture vacuum tight, temperature-resistant tools.

In order to have vacuum tight tools, the sheet metal surfaces must be joined together to form an anatomic bond. This is accomplished by soldering and diffusion bonding techniques. Soldering has several drawbacks including the need for flux and filler metal, reduced mechanical strength and the working temperature of the finished part and problems of solder flow into functionally significant hollow spaces of the tool. These drawbacks do not arise. in diffusion bonding.

The combination of laser cutting and diffusion bonding enables bulk tools and tool inserts with a mechanical and thermal load-bearing capacity and complicated internal contours to be produced. All grades of steels can be used including tool steels. Different steel grades can be joined and other materials, such as hard metals or copper alloys can be integrated[1,2]. Hence, so-called 'gradient tools' can be produced in which at each point, the material that is most suitable for that part of the tool is employed e.g. a high thermal conductivity material where fast heat removal is important, or a wear-resistant materials on the edges of a forming die. The wear resistance of functional surfaces can be improved subsequently by laser heat treatment.

Technological sequence

As in all generative methods, the basic idea is to reduce a three-dimensional problem to several simple two-dimensional problems.

An extended 3D-CAD model of the workpiece must be generated incorporating the necessary additional features needed for diffusion bonding e.g. positioning holes and holding devices. A software tool is used to slice directly in the CAD system and transfer the 2D shapes directly to laser cutting software. In most RP technologies, a constant layer thickness is used, but here sheets of different thickness' and/or different materials can be used. Geometrically simple sections of a tool can be integrated in the form of a compact part that can be manufactured by turning, milling or erosion. The whole process is shown in Fig. 1 for the manufacture of air bearing cages.

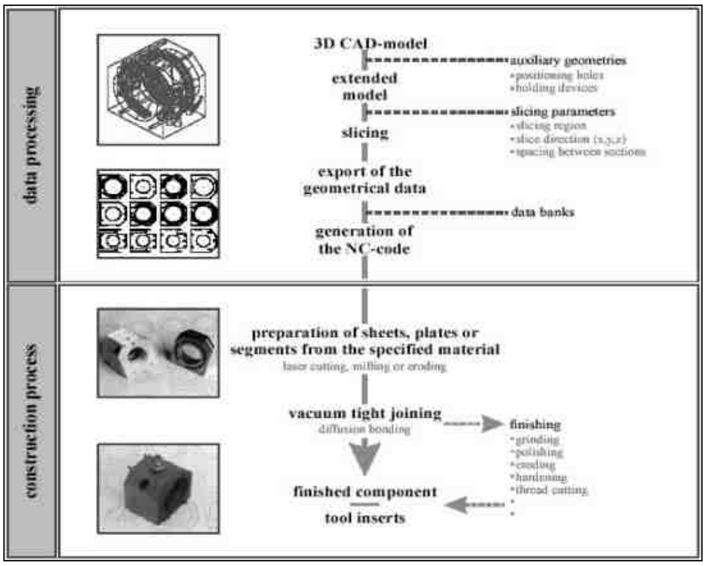


Figure 1 Operational sequence for the manufacture of a prototype double-spherical air bearing.
The bearing cages are made from CrNi steel 1.4301,with a sheet thickness of 0.5 and 1 mm. The development was carried out in close cooperation with the Precision Engineering Laboratory of the Federal University of Santa Catarina, Brazil. Particular attention was paid to the integration of special air distribution channels. Such bearings are used, for example, in machine tools for high-precision metal cutting.

Laser cutting

A disadvantage in the surface of prototypes or tools made from sheets is the stepped nature of the surface(see Fig. 2). The size of the steps and, thus, the contour depends on the sheet thickness. Since use of very thin sheets is not always economical we decided to establish the degree of improvement gained by creating the sheet lamellae contours with sloping edges.

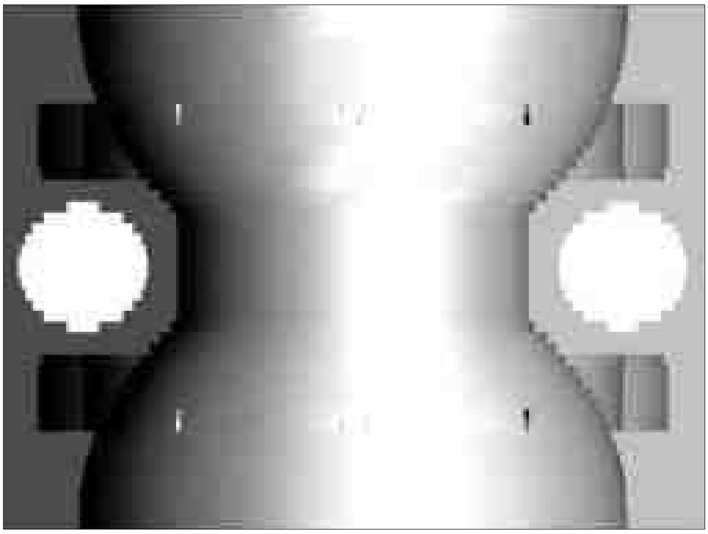


Fig 2 Stepped structure of a laminated part

Tests were carried out at the Institute of Joining Techniques and Material Research in Jena on a 5-axis Trumpf laser cutting system. The cutting results obtained with 1mm-thick sheet, up to an angle of 15°, compare well with those obtained at an angle of incidence of 90°. Angles of incidence ≥20° led to a distinct deterioration of the cutting quality (i.e. larger gap widths, larger heat-affected zones, increase in the roughness of the cutting surfaces, formation of burrs), well-known effects caused mainly by insufficient blowing out of the kerf. Further problems resulted from the braking and acceleration of the cutting table when changing the cutting direction.

Attempts were made to produce the mould cavities of injection moulded tools and pressure-die casting tools without post-removal of the steps, by using precision sloping-edge cutting of the sheet lamellae, but at this point the technique has not yet achieved a level where mould cavities can be made without post dressing. It is nevertheless a means of manufacturing parts with close to final surface contours and, as illustrated by the examples below, by using straight cut sheets, tools can be manufactured which are not only tools for mass production, but have better properties due to the cooling channels i.e. the stepped nature of the surface offers the advantage of increased surface area.

Diffusion bonding

Diffusion bonding, the pressure-welding process based on solid state diffusion, is preferentially undertaken in a vacuum, with an applied pressure in the range 0.1 to 20 Nmm^{-2} and a working temperature below the solidus line. In this way, laser-cut sheets, free from burrs, scale and distortion, can be joined in a vacuum-tight manner over their whole surface without generating a molten phase.

After cleaning the sheets are fixed in a positioning device where they remain during the bonding process. (Cylindrical pins, taper pins, wedges, prisms or templates adapted to the shape of the tool are useful in positioning the sheets.) The diffusion bonding is achieved by maintaining a well-defined pressure-temperature-time-cycle. Plastic deformation in the microprofile ensures that the surfaces to be joined make intimate contact, so that solid-state diffusion can occur. The tool inserts described below contain up to 80 sheets.

Diffusion-bonded compounds are highly stressable both thermally and mechanically, and also leak-proof and gas-vacuum tight. The mechanical strength of the bonded part lies in the range of the base materials.

Material Selection

Prototypes, tools and tool inserts are, in general, manufactured from steel sheet of various thickness'. Both CrNi steel and tool steel can be employed, making this method is distinctly superior to laser sintering. The sheet thickness is chosen by consideration of, firstly, the complexity of the geometry of the parts and the required imaging precision, secondly the machining time and cost of laser cutting (in general the aim being to have as few layers as possible) and finally, the achievable cut quality. Typical sheet thickness' to date have been between 0.5 mm and 1 mm, but also foils with a thickness of 0.2 mm and tool steel sheets 2 mm thick have also been used.

Despite the wide range of sheet available, the selection of optimal materials for lamellae tools is restricted at least for mass production. In particular, not all steel grades commonly found in tool and die making are available in thickness' that can be laser-cut in an economical way and with good cutting quality. The tooling inserts presented below were made of austenitic CrNi steel grade 1.4301 (X5CrNi18.10) or from precision flat steel grade 1.2510 (100MnCrW4). The sheet thickness was 0.96 ± 0.005 mm for the thin sheets and 1.04 ± 0.015 mm for the sheets made of precision flat steel. The sheets presented the following roughness':

Thin sheet 1.4301	Rt= 1.0 to 1.8 µm/ Ra= 0.06 to 0.15 µm
Precision flat steel 1.2510	Rt= 4 to 13 µm/ Ra= 0.5 to 1.5 µm

For thin sheets, the laser-cut edges had a roughness of Rt= 15 µm and Ra= 2 µm, and the burr presented a height of 1 to 5 µm. Such sheets could be diffusion-bonded without any reworking required.

Application examples

Tools designed to improve better heat conduction are the current focus of our research activities. The control of the heat flow is achieved through cooling or heating channels of various shapes and dimensions, located under the surface so as not to impose any constructional limitations. The heat flow can also be controlled by combining materials of different thermal conductivity. The combination of laser cutting and diffusion bonding offers both possibilities.

In the past, cooling or heating channels would be produced by drilling, milling or eroding. In many cases, these methods would not allow the channels to follow the contour of the component. However, it is essential in many modern manufacturing process-

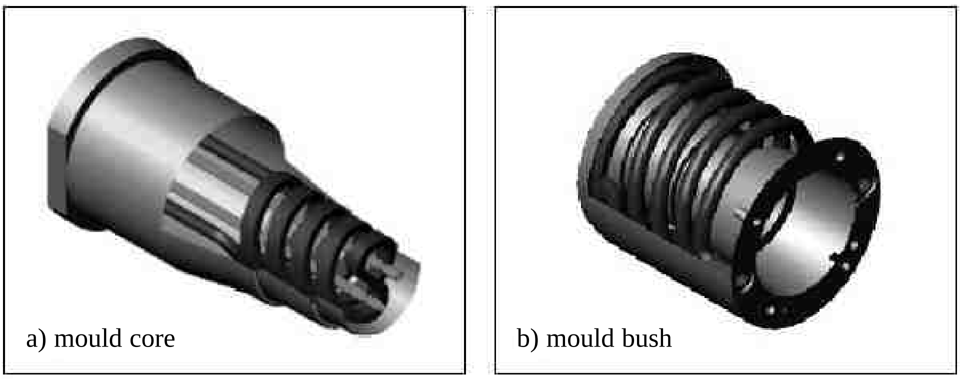


Figure 3. CAD model showing the arrangement of cooling channels in a mould.
As shown in Fig. 3a, a largely flexible arrangement of the temperature-controlling channels between the ejection pins is possible. Both round and rectangular cooling channels of different sizes were realized.

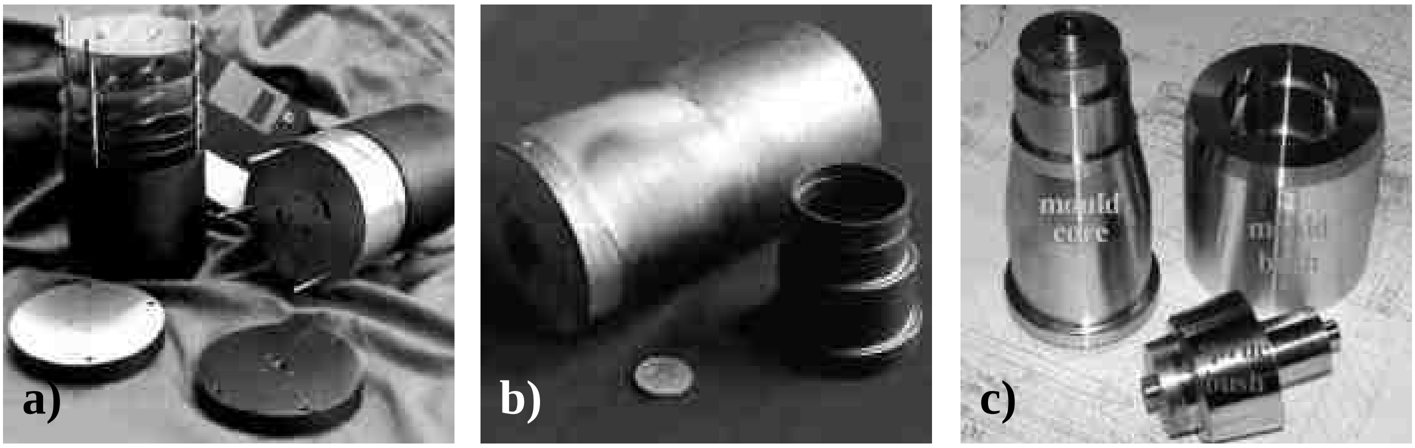


Figure 4. (a) the stacking of the sheets in preparation for diffusion bonding; (b) the bonded mould prior to finishing; (c) the finished mould inserts

es to control the dissipation or supply of heat in order to achieve the required quality of product. This applies particularly to the injection moulding of thermoplastics and to the die casting of light metal alloys.

The availability of variable temperature control also makes increased process reproducibility possible. With the new technique, the channels can be arranged in such a way that they follow the contour of the shaped part, guiding the cooling agent directly to the requisite site. In this way, the heat can be dissipated faster from the injection moulded component, and the manufacturing times is reduced. In injection moulding, it is not only important to maintain the required quality of the shaped parts, but also to maintain a low cycle time. The uniform temperature control of the injection tool leads to a higher quality of the plastic injection moulded parts. Furthermore, whereas in general injection tools are cooled, in the case of special plastic moulding materials or tools having several points of injection heating may also be necessary.

Figure 3 shows examples of the arrangement of the cooling channels. The region where no change in the direction of the temperature-controlling channel occurs was not sliced and served as socket for the positioning pins during diffusion bonding, as shown in Figure 4a. Due to the low maximum contact pressure of 10 Nmm^{-2} during diffusion bonding, the tool inserts could be joined without serious no distortion. In the case of a tool insert consisting of 68 sheets and surface roughness of Rt=1.5 µm, the change in height on welding was only -0.1 mm. The decrease in height is due to the roughness of the single sheets.

For a variety of reasons, the surface finish on the bonded parts was not sufficiently high for plastic forming and so the tools were made slightly oversize. Figure 4b shows the bonded mould core prior to finishing and figure 4c shows the finished parts after turning, HSC milling or grinding depending on the contour.

Subsequent machining presented no problems. The parts could be eroded, heat treated or tapped. The water channels of the tool inserts were successfully pressure tested up to 1700 bar, a far superior result to tool inserts manufactured by laser sintering. The hardness of the bonded inserts made from steel 1.2510 was 54HRC, thus demonstrating that the tool could be used directly for mass production of parts.

A comparison was made between a conventionally produced tool with a rapidly prototype tool. Both sets were used to produce approximately 800 parts in ABS and the cycle times were compared. If the slug is removed automatically, cooling time could be reduced from 12 to 9 s despite the fact that the conventionally manufactured tool was provided with extensive temperature control. This reduction of 25% in production time could be improved to 50% if the separation of the slug was undertaken separately.

Some other small injection moulding forms have also been produced by rapid prototyping for parts already in service and have been found to perform better than conventional mass production tools. However, the size of the tool inserts that can be manufactured by using this technology is presently limited to a diameter of 100 mm and a height of 170 mm.

Summary

By combining laser cutting and diffusion bonding techniques, tooling inserts with contour-adapted channels can be manufactured which permit tools with 'smart thermal management' to be realized. Sheet lamellae structure offers the following advantages:

- The position of the temperature controlling channels can easily be adapted to the surfaces, shapes and contours to be cooled.
- The temperature controlling channels can have any desired shape and size.
- Stacking lamellar sheets causes small steps and terraces, thereby increasing heat exchange by increasing surface area and turbulence in the cooling channels.

Hitherto, scientific investigations have mainly focused on injection moulds. Fore these, a significant reduction in the cycle times for parts has been demonstrated, leading to an increased profitability from forming dies that require a heat conduction adapted to the material and/or the component. The aim of further investigations will be to make it possible to bond semi-finished products very close to their final contour with reproducible quality.

The project was carried out in cooperation between the Precision Mechanics of the University of Applied Sciences of Jena and the industrial partners FKT Formenbau und Kunststofftechnik GmbH Triptis and Nothnagel Thermoplastsysteme AG Unterschönau. The Technical University of Ilmenau was responsible for the coordination. The project was sponsored by the Thüringer Ministerium für Wissenschaft, Forschung und Kultur, for which the authors express theirs thanks.

This article is based on a paper presented at the ICALEO Conference (Jacksonville, FL. USA 15 - 18 Oct. 2001). and is published with the kind permission of the Laser Institute of America.

Flexures and Flexural Pivots

David C Brown

GSI Lumonics Inc.

39 Manning Road Billerica Massachusetts01821 USA

T: +1 978 439-5511 x6315 F: +1 978 663-8526 E: brownd@gsilumonics.com

Flexures are of considerable interest to those concerned with the application of lasers to manufacture. There are a number of distinct reasons for this, including:

- **Literally billions of flexure assemblies are manufactured every year using laser welding or cutting. Most are incorporated into devices with working lives extending to millions or billions of cycles. The minority includes cases where the flexure is operational only during the product set-up and calibration; in these cases, lasers may be used to effect the adjustment and / or lock it.**
- **Flexural pivots play a vital role in both resonant and galvo scanners used as critical components in many industrial lasers used for marking or welding.**
- **Much laser-processing tooling uses flexures as cheap, effective and robust bearings with negligible lead time.**
- **The production of flexures is often combined with other laser processes to eliminate components or process steps.**

Lasers in Manufacturing

In spite of its antiquity and widespread use, the valuable characteristics of the flexure mean that it deserves to be used more widely and more deliberately.

Know-how exists as a result of three modern ‘surges’ of development: in the 18th and 19th centuries in response to the needs of scientific instruments; in the 1960s and 70s to meet the needs of space applications, and in the 1990s and currently in furtherance of the development of MEMS (micro-electromechanical systems)

What is a flexure?

A flexure functions as a bearing often consisting of a single element. As a rotary device it is often used to mimic the performance of a linear bearing. Familiar examples include: the fold in a sheet of paper, that acts as a hinge between the resulting pages; the straps of many ancient and present-day trunks, that form hinges for the lid; the suspension of a clock pendulum. More modern examples include: the flexural pivot of a galvanometer; the flap valve of a compressor, a disk drive head carrier.

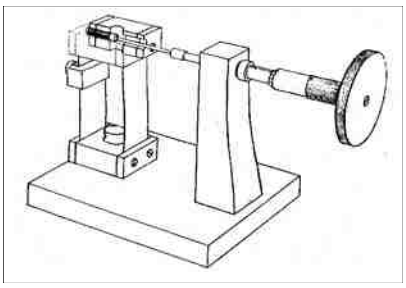


Figure 1: Simple parallel spring movement from Ref 1.

In essence, a flexure is a simple bearing with:

- Limited travel
- Low friction and hysteresis
- No wear
- No lubrication or outgassing
- Low mass and inertia
- Immunity to environmental problems
- Tailored stiffness in each axis
- Low part count
- Constant electrical and thermal conductivity

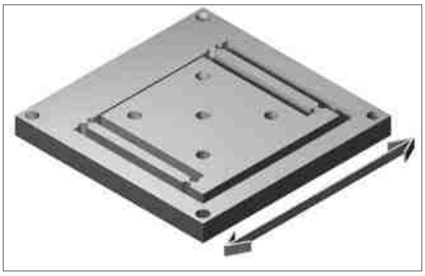


Figure 2: Laser cut flexure permitting movement parallel to a single axis

It is often implemented as part of another component and may not have any existence other than as part of the assembly. For example, figure 2 shows a simple flexure implementing four pivots.

Limitations

A flexure does have some limitations, including:

- Limited travel – flexural pivots are suitable for up to 90° rotation as a practical maximum
- Internal resonance – in some configurations, particularly of very precise linear flexures, there are suspended masses which may respond to vibration inputs
- Cross-talk – motion in one axis may result in unintended motion in another axis; in fig 2, a small motion perpendicular to the arrow results from motion parallel to the arrow.

Awareness allows these problems to be avoided. For instance, the cross-talk problem in fig 2 may be eliminated by attaching the centres of two such components, the top one being inverted relative to the bottom. The true parallel motion then takes place between the two outer frames. Because the bolted centres are now a mass supported on the ‘springs’ comprising the eight flexural pivots, there is a risk of it resonating in response to any vibration input.

Life

In many systems, for example disk drive suspensions and resonant scanner pivots, extreme life is required and achieved by detailed attention to the choice and condition of the material and the design. These issues are outlined in ref 2. However, in the general run of laser cut or laser welded flexures, the required performance and life is less demanding. Whilst it is still necessary to consider the issues that impact fatigue life, a less rigorous analysis may be adequate.

Particular points to consider in this regard are:

- Avoid stress raisers such as sharp notches or changes of section, or poor surface finish.

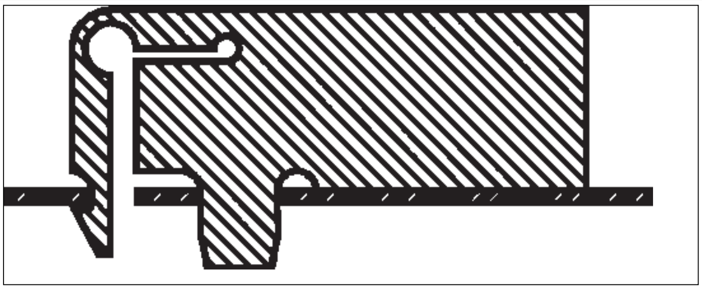


Figure 3: One form of latch where location is established by a dowel while retention is by the pawl suspended by flexures.

- Be attentive to conditions that could cause corrosion, particularly electrolytic corrosion

Other Properties

Frequently, a flexure is called upon to do more than to be a bearing. For example, it may be required to provide a restoring force, as is commonly the case with catches and latches. It may include protection against over-travel as is inherently the case with the example in figure 2.

Simple flexures are widely used in the latches to replace fasteners, particularly for assemblies of sheet metal components or of mixed moulded and sheet metal parts. In these cases, the flexure may be required to have a high restoring force in one axis but a modest one in an orthogonal axis. Figure 3 indicates a low-rate flexure which engages the latch itself while a higher-rate flexure establishes the force normal to the 'mother plate'. It is easy to see that such an attachment is simple and cheap to produce by laser cutting.

Flexural Pivots for Galvanometer Scanners

Though not normally manufactured using lasers, galvanometer scanners are of considerable importance to the implementation of laser systems for marking, multiple-spot welding and some short-path seam welding. They are also vital to the operation of high-speed optical fibre switches used in some diode-laser and YAG laser applications. These applications are so widespread that standard sub-systems have been developed by my own company and its several competitors.

The advantages of flexural pivots in these scanners are:

- Ruggedness.
- Low mechanical losses.
- High transverse stiffness.
- Near infinite life.
- Low noise.
- Precision.
- Constant electrical conductivity, eliminating the slip ring noise.

Disk Drive Flexures

The flexure functions as a gimbal; it must be very stiff in all three liner and one rotational axis but compliant in the other two rotational axes. Its function is to allow the head to 'ride' parallel to the disk whist being located in exactly the correct place.

Many flexures are manufactured by laser spot welding. As precision is a key requirement, special action must be taken to prevent misalignment due to weld shrinkage. The trick is to lay down a pattern of welds, symmetrical about the critical axis, all the welds being made simultaneously. The distortion caused by each weld point is the same, so the symmetry means that there is no significant distortion in the critical axis.

MEMS

Micro-electro-mechanical systems make substantial use of flexures in a wide range of applications, not least in scanners for optical switching. It turns out that silicon is an excellent material for flexures, both in terms of its properties and because of the availability of suitable manufacturing technologies (Ref 2). In particular, it has excellent fatigue life. However, we are unlikely to encounter MEMS as an application for the general run of manufacturing with lasers.

References

1. Parallel and Rectilinear Spring Movements; R V Jones; J Sci Instrum, 28, p38, 1951

2. Flexure Pivots for Oscillatory Scanners; D C Brown; Chap 10 of Handbook of Optical and Laser Scanning; G F Marshall (Ed); Marcel Dekker inc; to be pub 2002

3. How to Design Flexure hinges; J M Paros and L Weisbord; Machine Design, Nov 1965, pp 151-1564. Designing Springs for Parallel Motion; G H Neugebauer; Machine Design Aug 1980, pp 119-120

David Brown has been about precision mechanisms since childhood. This has stood him in good stead in his development of static instruments and those carried in submarines, aircraft and to the moon. He is currently Director of Exploratory Development at GSI Lumonics, Inc., where he develops MEMS and other micro-scale mechanisms for the telecommunications industry.

Annual Members' Meeting 10 April 2002

Spectron Laser Systems Ltd, Rugby

Developments and Trends in Industrial Laser Use

including

'The Industrial Laser Market' presentation and forum discussion

'What's New in 2002?' commercial review

'Spotlight on laser-based manufacture' presentation

Contact AILU office for more details and reservations

Lasers in medical device manufacture

Andrew May

Rofin-Baasel UK Ltd

3 Brunel Close Drayton Fields Daventry NN11 5RB UK

T: +44 (0)870 990 1020 F: +44 (0)870 990 1030 E: a.may@rofin-baasel.co.uk

In the business of Medical Device Manufacturing the laser addresses the need to cut microscopic features, fine weld with a minimum heat affected zone and provide highly-resolved markings for traceability of instruments and implants.

Fine Cutting

Of the two common industrial lasers, the CO_2 laser has a ten times longer wavelength than the Nd:YAG and, all other considerations being equal, a correspondingly larger kerf width (typically around 50 - 70 µm) when laser cutting. Many medical applications require finer features and for this the Nd:YAG laser is often preferred. Pulsed Nd:YAG lasers for laser cutting are available up to kilowatt levels, but for the fine cuts average powers typically less than 7W are used. Table 1 provides a guide to appropriate power levels.

An increasingly commonplace medical device is the coronary stent, which acts as a tiny 'scaffold' to support internal artery walls when expanded using balloon angioplasty. The laser is ideally suited to the production requirements of these and other types of stent. Sub-millimetre diameter tubes can be cut with kerf widths down to 18-20 µm, as shown in figure 1. The product typically goes through

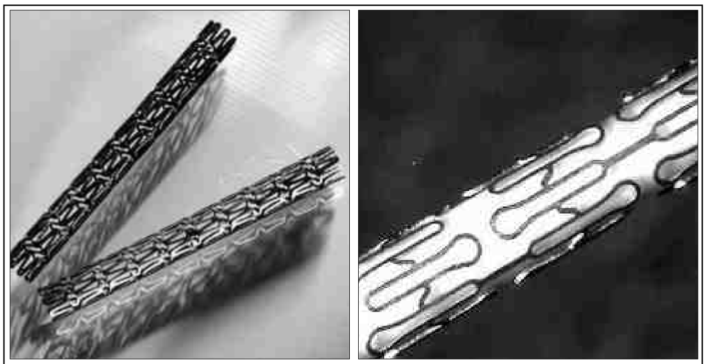
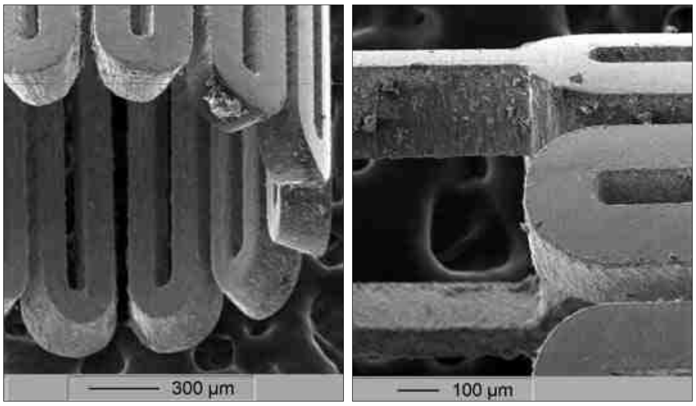


Figure 1. Intracoronary stents cut from sub millimetre tube by laser. *Electron microscope pictures of a cut stent, below, show the high cut quality of the laser and cut widths of 18µm. The Nd:YAG laser operating in fundamental (TEMoo) mode was used for this work.*



Max. average laser power (W)	7	12	22	150
Typical kerf width	18 – 30	30 - 60	60 - 100	100 - 300
Max. material thickness (µm)	400	600	800	3000
Typical cutting speed range (mm/s)	1 – 5	5 - 15	15 - 40	5 - 50

Table 1 Approximate laser powers required for fine cutting stainless steel. *The data refers to the Rofin-Baasel StarCut SC18 and (far right column, the SC150*

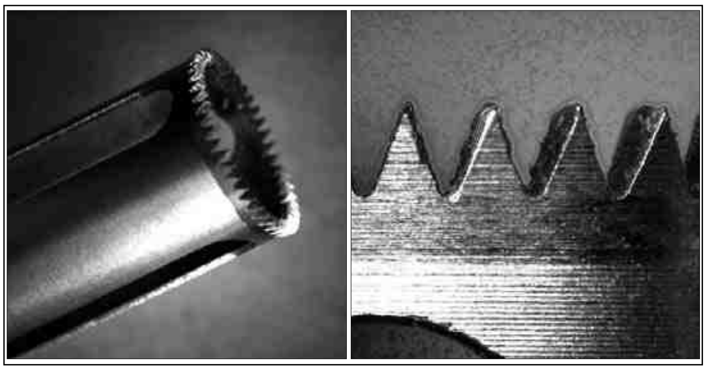


Figure 2. Laser cut saw-teeth on a cylindrical skull-cutting device.

an acid/vibration cleaning process after cutting, but the quality of cuts directly off the laser is remarkable, as can be seen in the electron microscope pictures.

A heat affected zone during laser cutting of less than 3 µm in typical grades of steel is another attraction of using the Nd:YAG laser, one that can be put to good use in the cutting of surgical drilling and sawing instruments. By using an inert assist gas (nitrogen, argon) instead of oxygen, melting at corners can be avoided during the cutting process. In practice, laser-cut saw teeth are so sharp and clean that almost no post treatment is necessary, see figure 2.

Figure 3. A high precision (dry process) tube cutting system with automatic tube feeding. *Such a system can take unlimited lengths of precision tube steel, cut it to length and add CAD-designed structures, operating automatically for several hours without requiring reloading.*

Figure 4. Laser machining of a surgical hip grinder. *The part is a produced out of a hemisphere of metal on a 5 axis laser cutting system. The wall thickness is about 1 mm and the laser cutting process was chosen by this medical instrument manufacturer because of its flexibility, precision and processing speed.*

A commercial tube cutting system is shown in figure 3. Similar systems can be used to laser machine other fine structures such as filters, slotted tubes to create debris-collection ‘baskets’ and miniature springs, which can be individually designed to have exactly the performance parameters demanded by a product.

Applications for more powerful multimode Nd:YAG lasers include cutting a part for a surgical hip grinder, as shown in Figure 4. Lasers can also be used to cut scalpel blades directly from pre-hardened steel coils or sheet, thereby overcoming the need for the post- hardening process.

Fine Welding

Laser welding offers minimum heat input, thereby minimising component distortion. Since laser welding is a non-contact process it is possible to work on miniature components with simple clamping and to access joint locations where an electrode could never reach.

Metal welding

For welding metals, typical Nd:YAG laser parameters include average powers of up to 1000 W and pulse energies of up to 100 J. Spot welding allows the precise joining of small components to create complex miniature mechanical or electrical connections.

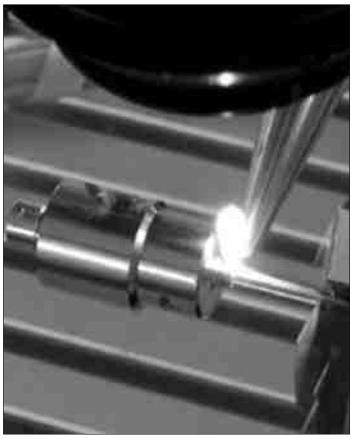


Figure 5. Laser welding of metals in medical device manufacture.

Figure 5a. Cylindrical laser welding.

Hermetic seam welding of metallic components is often vitally important in medical components (for example implanted electronics) and the laser is able to achieve this with a smooth surface finish, which is essential for antiseptic conditions.

Figure 5b Multiple spot welds using ‘galvo head’ beam delivery

‘Galvo head’ beam delivery makes it possible to provide multiple sub-millimetre spot welds in a fraction of a second. Weld positions and parameters can be PC-controlled for both speed and precision.

Figure 5 gives two examples of laser-welding techniques. Medical applications include pacemakers, endoscopes, brain clamps, implants and minimally invasive surgical devices. A variety of different laser solutions are available, ranging from manual welding stations to fibre-delivered semi- or fully- automated systems, if necessary incorporated into glove boxes.

Polymer welding

A breakthrough in laser polymer welding came recently with the availability of the High Power Diode Laser. Most polymers are transparent in the near infrared spectral region, where HPDLs typically emit, but can be made absorbing by the addition of materials such as carbon black or special pigments. This provides an opportunity to create overlap welds by heating the interface created by contacting an absorbing plastic layer with a transparent layer of plastic. .An alternative application is to use the diode power to create a plastic to metal bond, as shown in Figure 6.

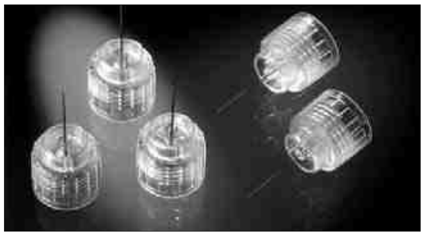


Figure 6. Metal needles diode-laser welded into polymer carriers.

Marking

Metal and plastic surgical implants have long been marked almost exclusively by laser, see figure 7. plastic components for testing kits and drug delivery mechanics have batch codes, scales and dial numbers created by laser; sell-by dates are etched onto drug packaging. Matrix codes facilitate marking of codes containing 20 or more characters onto spaces only a few millimetres across

Drug packaging and medical fields are particularly attracted to laser marking because of its cleanliness and anti-counterfeiting capability.

Figure 7. Medical implants and instruments are routinely marked by laser

Surface Treatments

New surface treatment applications for lasers include stripping away coatings from guidewires to provide reference points for the surgeon as to the extent of insertion. Such clean surface ablation can be extended to the creation of micro-plastic injection moulds in tool steel, as shown in figure 8. Laser-scanned multi-pass erosion can create precise cavities from CAD designs, without the need for mechanical or electric discharge machining.

Figure 8. Micro-mould creation

Surface hardening

Another new application for the high power diode lasers is the transformation hardening of metals. Applications include locally hardening of surgical blades or needle/syringe tips and critical wearing edges on the micro moulds, such as shown above.

Laser-assisted manufacture of a GPS antenna

Oliver Lleisten[a], Jim Fieret[b*], Ines Stassen[b], Phil Rumsby[b], Patrick McEvoy[c], Yiannis Vardaxoglou[c]

a **Sarantel Ltd** Rutherford Drive Park Farm I.E South Wellingborough NN8 6AQ UK
b **Exitech Ltd** Hanborough Park Long Hanborough Oxford OX29 8SL UK
c **Loughborough University** Dept. of Electronic and Electrical Eng. Loughborough LE11 3TU, UK

*j.fieret@exitech.co.uk T: +44 (0) 1993 883324 F: +44 (0) 1993 883334

The use of ceramic cores of high dielectric constant is an essential part of a strategy to miniaturise Global Positioning System (GPS) antennas for mobile telephones. The core reduces the guide wavelength of the conducting structures on the antenna, thereby creating a need for high-resolution UV excimer laser mask imaging to maintain very accurate dimensions to produce the conducting features on the surface of the antenna. Further, a significant process challenge in producing this type of antenna concerns the reproducibility of performance and the need to be able to tune the antenna. In this case a laser trimming process involving a galvanometer controlled Nd:YAG laser spot was used. Laser technologies are shown to play a pivotal role in the manufacture of antenna for cellular telephone handsets, using techniques also appropriate for other antenna types such as GSM, Bluetooth and Wireless LAN.

Introduction

The use of an appropriate antenna for a GPS receiver is the quadrifilar helix antenna. Sarantel have developed a highly dielectrically loaded form of this type of antenna, see figure 1, that is six times smaller than an equivalent air-loaded antenna. It comprises a zirconium tin titinate ceramic puck, 17.75 mm in length and 10 mm in diameter, which acts as a substrate to a thin layer of copper.

The lower section of the antenna is a sleeve balun (balanced-unbalanced). The distance from the cable solder point at the base of the antenna to the balun rim is designed to be 90^0 in electrical length. It acts both to isolate the radiating section of the antenna from surface currents on the application device and to transition the otherwise inherently unbalanced currents from the cable to a balanced feed for the loop.

Antenna manufacturing processes

The manufacturing process consists of plating and etching techniques that are well known for printed circuit board technology but is new to three-dimensional ceramic components. The ceramic pucks are processed in batches through a series of electroless and electrolytic plating baths that deposit a thin layer of copper, followed by the application of a UV-sensitive electrophoretic photoresist. Care must taken to ensure the copper layer is distributed evenly across the ceramic surfaces and that the electrophoretic photoresist is applied with a regulated viscosity.

The antennas require a copper pattern with tight dimensional tolerances onto a cylindrical surface, with precise match-up with a pattern on the top surface. All pattern dimensions need to be kept to within tight tolerances, and some dimensions on the cylindrical surface (e.g. the balun height) have to be kept to within a few microns.

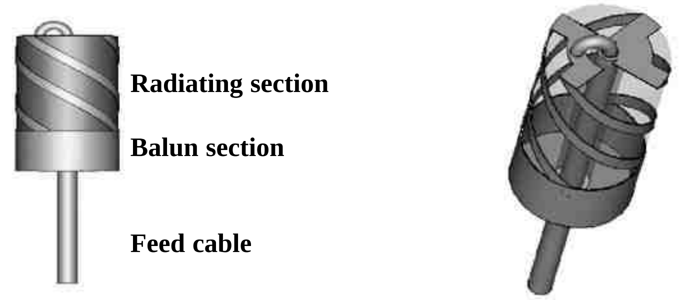


Figure 1. Dielectric-loaded quadrifilar helix antenna
The image on the right shows the pair of diagonal resonant loops that are fed at the top of the antenna using a co-axial cable passed through the ceramic.

<u>Selection of process</u>

Various industrial processes, all based on photoresist and etching procedures, were assessed for their suitability. Use of a conventional UV light source (e.g. mercury lamp) would necessitate the use of a metal sleeve contact mask with the required pattern machined into it. This approach was ruled out on the basis that (a) the need for a small gap (to prevent damage the photoresist when applying the sleeve) limits accuracy, (b) sleeves can be expensive and slow to manufacture, with long lead-time, and (c) in order to achieve acceptable cycle times (a few seconds per antenna), multiple sleeves would be required for batch exposure, since the typical exposure time is a minute or so.

Direct laser machining of the copper with a raster-scanned focused beam (e.g. from a Nd:YAG laser) is possible but slow compared to lithographic techniques. Accuracy would require the laser to operate in TEM_{00} mode, which currently sets a output power limit of ~30 W, and such a laser would only process about one antenna per minute. A narrow process parameter tolerance (e.g. to small variations in the copper thickness), the risk of excessive laser exposure of the underlying ceramic and debris management issues are further drawbacks.

Direct ablation of the photoresist is possible, and this process can be made to work considerably faster than copper ablation. With the highest power industrial excimer laser currently available, the throughput can be an order of magnitude faster than copper ablation. The disadvantages of this method are the high capital and running costs of the excimer laser and, again, debris management.

On the other hand, exposure of the photoresist to a low power UV excimer laser can effectively cross-link the photoresist of an antenna in less than one second so that, providing the robotic handling system can work fast enough, potentially very high throughputs can be achieved. The capital- and running costs of such a

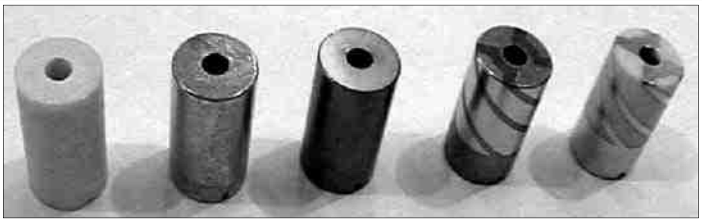


Figure 2. Laser plus lithography. *From left to right: bare ceramic substrate, copper coating, resist coating, after exposure and development, after copper etching and resist stripping*

laser are modest and the additional lithographic step that is required (i.e. the removal of the unexposed photoresist) is inexpensive and can easily be integrated into the same bench as the other wet steps of the antenna production. This method was therefore selected and implemented for the antenna production line. Figure 2 shows the various steps in the process.

Process development

The exposure tool uses a high repetition rate UV excimer laser with low pulse energy to expose the photoresist at a radiation dose adequate to expose the photoresist all the way down to the copper and a fluence that is sufficiently low not to cause ablation- or other damage to the photoresist. The thickness of the photoresist and the choice of excimer laser are closely correlated. A program of research was carried out to determine the optimum combination of excimer laser wavelength and resist thickness in order to determine the best compromise between process speed, yield and cost.

Antenna substrates are held firmly in position through their bore by spring steel pins. The base of the pin is nickel plated and widens into a cone that acts as a mirror to expose the base of the antenna at the same time as the sides. The pin is mounted on a rotary stage with z-elevator, fixed on top of a high speed linear stage which moves the antenna substrate from the loading to the exposure position. Transfer is via an intermediate position where the height of the antenna top face is accurately measured with an optical sensor and the position of a small notch at the base of the antenna substrate is determined (also with an optical sensor). The notch is necessary because subsequent robotic assembling and soldering operations need alignment to a mechanical feature. The top and side patterns need to be positioned precisely with respect to the notch.

The antenna substrate is exposed to laser radiation on the top and bottom faces and over the whole of its side circumference. The chrome-on-quartz photomasks were illuminated with a narrow line of UV laser light, and the transmitted light imaged onto the substrate with a high resolution, diffraction limited telecentric lens. The line of laser light was scanned across the mask in synchronism with rotation of the substrate.Figure 3 shows the photomask patterns that were used.

After imaging the side pattern, a pneumatically operated mirror drops into the laser beam to re-direct it for the top face exposure. Since both the side and the top pattern photomasks are held on motion stages, the exposure tool can quickly change from one antenna design to another simply by moving to a different pattern in another area of the photomask. Figure 5 shows the complete laser imaging tool.

Figure 3 (above) Exposed antenna
(left) side pattern; (middle) top pattern; (right) mask images for GPS antenna.

Figure 5 (above) Exitech M4000X Excimer exposure tool. figure 6 (left) a complete antenna with (top) and without matching box

After laser exposure, the substrates are dipped into a sodium hydroxide solution to remove the resist from the unexposed areas of the antennas, followed by a copper etching and resist stripping procedures. An automated fabrication line assembles the antennas with a connector pin and matching box (see figure 6).

Laser trimming

In order for the antennas to operate at precisely the correct frequency of 1575.42 MHz, within a tolerance of 2 MHz, the majority of antennas produced need small adjustments to the induction loops formed by the copper pattern on the antennas. This trimming requirement exists despite the excellent accuracy which can be achieved with laser imaging of the pattern, and is primarily a consequence of the spread in antenna dimensions, dielectric properties of the ceramic material, and copper thickness and resistivity.

The trimming is carried out with a fundamental mode Nd:YAG laser in TEM_{00} mode. The laser beam is focused onto the antenna by means of a flat-field (f-theta) lens, and scanned across the top surface of the antenna by means of an x-y galvanometer in order to ablate small areas of copper.

The laser trimming tool is integrated in a robotic assembly loop which fits the matching boxes to the antennas (this loop is separate from the antenna assembly line). A pick-and-place robot picks up an antenna with fitted matching box and places this in a pneumatically actuated chuck on a high speed linear stage which moves the antenna into the laser-safe trimming tool enclosure through a pneumatically operated door. Once in the trimming position, four RF probes mounted radially around the antenna are moved to close proximity of the antenna perimeter, at the balun level such that each probe is located at the base of each of the four spiral arms. The resonant frequency and balance of the antenna is measured with the probes and a network analyser with specially developed trimming algorithms determines the amount of copper (if any) needed to be removed from each of the four arms of the antenna top pattern. The trimming algorithms were developed by Sarantel specifically for this purpose.

Conclusion

Laser technology can fulfil a critical role in the high-volume manufacture of small GPS antennas that are suitable for E-911 emergency handset location. The methodology that has been described in this paper is embodied in a manufacturing process that is available for licence from Sarantel Ltd.

Comparison of solders for diode laser use

Tony. Hoult* and R.S. Ong

Coherent Semiconductor Division Santa Clara California USA

A.P. Malshe and A.R. Dhamdhere

Mechanical Engineering Department University of Arkansas USA

*T: +1 408 764 4379 F: +1 408 764 4329 E: tony.hoult@coherentinc.com

The acceptance of laser soldering by the microelectronics industry has recently increased dramatically due in part to the development of reliable, efficient direct diode lasers. Similarly, soldering using lead-free solders has also increased, largely due to current or impending legislation across the world aimed at reducing the usage of lead.

The majority of systems currently employed for laser soldering produce joints sequentially as opposed to conventional soldering processes, such as wave soldering, which produce a large number of joints simultaneously. The average power of the laser required in most cases is relatively low, most joint configurations require less than 10 watts to produce a single joint, although there are some solder reflow applications in which a number of pads are scanned simultaneously, where higher average power is required. Sequential soldering puts the process well within the power range of diode laser devices. Similarly, power density requirements (Watts/cm^2) are relatively low; indeed, if excess power density is employed, poor joint quality can results due to spattering.

Lead-Free Soldering

Since the start of the electronics industry lead-containing solders have been used almost exclusively. Lead-free soldering has been introduced as a response to proposed legislative restrictions on the use of lead in electronics and by marketing activities in the Far East and Europe. Various publications have laid out proposed alternatives to lead-containing solders but there has been a general consensus that there is no 'drop-in' replacement immediately available. However, there is some agreement that the tin-silver (Ag-Sn) group of alloys is functionally equivalent to the lead-tin (Pb-Sn) alloys in certain situations although there is still some concern over replacements for higher temperature (~300°C) lead-based solders. Inevitably, specific soldering applications will employ specific lead-free compositions, making it difficult to choose a generic composition to study. However, a combination of factors such as availability, mechanical properties, melting point and patent issues (covering certain compositions) led to the choice of tin-silver (96.5%Sn 3.5%Ag) as the material composition to study.

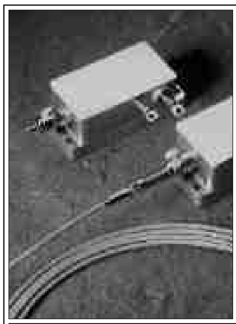


Figure 1. Laser arrangement. *The standard commercial system (below left) contains a 980 nm Fibre Array Package (FAP) module (left). The FAP module is built around a single 19 emitter diode laser bar, with each emitter coupled into an individual fibre. The 19 fibers, within a 800 µm diameter flexible fiber bundle are coupled to a standard Optical Imaging Accessory (OIA), shown below left and right. This two-lens OIA provides a 1:1 image of the fibre tip at the working distance of 33 mm from the focusing lens.*

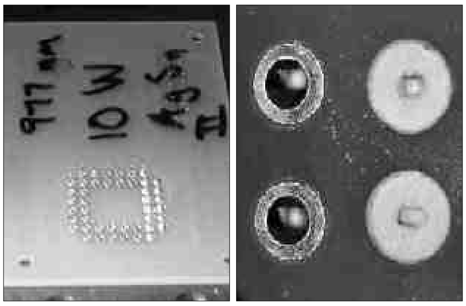


Figure 2. A sample board and preforms. *Pre-placed fluxed solder pre-forms were used to reduce variability of results. In particular, use of pre-forms ensured a consistent volume of solder to each pin.*

<u>Experimental arrangement</u>

The laser arrangement used for these studies is described in Figure 1 and shows the solder set-up, while figure 2 shows the circuit board and solder joint configuration. The board is a small FR4 circuit board designed specifically for these investigations, with a range of pad sizes for investigating solder reflow. In addition, tin plated copper through holes on a pitch of 2.54 mm are provided on the board such that a standard 44-pin chip carrier could be soldered into the board. The through holes were standard tin-plated copper. Two alternative solder compositions were obtained in the form of flux coated washers; these were manually inserted onto the pins as shown in the figure.

The joint configuration shown in figure 2 used is representative of laser soldering applications in industry and is typical of those used in high-reliability circuit boards. Such joints are increasingly employed in applications such as under-the-bonnet safety critical automotive sensors, where reliability is paramount and hence good process control is essential. As boards become more highly populated, so a low heat input to adjacent board components during soldering is increasingly important.

The first composition studied was the widely-used standard 63% Pb 37% Sn eutectic solder with a melting point of 183°C. The second solder was 96.5%Sn 3.5% Ag eutectic solder, with a melting point of 221°C. As the pre-forms were pre-fluxed, no cover gas was used and all samples were prepared in air.

<u>Experimental trials</u>

Ranging trials showed that solder joints could be produced over a wide range of average power and pulse duration. The pulse duration was fixed at 0.8s and solder joints were produced over a range of laser powers. These trials showed that solder joints could be produced over a range of 6 to 12 W average power. To optimise soldering conditions within this range a realistic number of increments of average power were chosen and a total of 14 solder joints were produced at each power setting.

Results and Analysis

Results over the optimum range of 6 to 12 W average power are shown in figures 3 to 6 below.

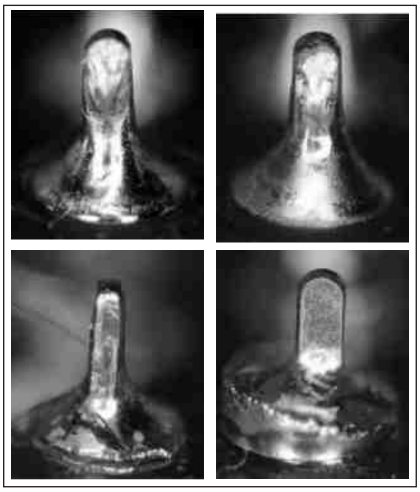


Figure 3. Lead-free solder
top left: 12 W, 0.8 s
a slightly overheated joint in which some slumping has occured.

top right: 10 W, 0.8 s
a good joint appearance

bottom left: 8 W, 0.8 s
'dry' joint.

bottom right 6 W, 0.8 s
'dry' joint.

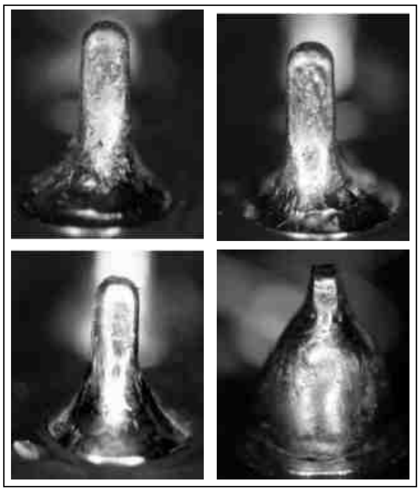


figure 4. Lead-tin solder
top left: 12 W, 0.8 s
a slightly overheated joint

top right: 10 W, 0.8 s
a slightly overheated joint

bottom left: 8 W, 0.8 s
a good joint appearance

bottom right 6 W, 0.8 s
'dry' joint.

Discussion of Processing Results

It was observed through the course of the experiments that the higher melting point of the AgSn solder was readily achieved with the laser process by a simple increase in power.

Many features of the solder joints could be determined simply from a low optical power examination of the completed joints. Firstly, low power settings (6-8 watts) all produced poorly wetted joints whereas higher power settings all produced signs of overheating. Mid range power settings produced joints with the best visual appearance i.e. no overheated flux and good solder wetting up the pin.

One common feature noted in the metallographic cross sections for both solder compositions was the presence of many shrinkage pores at low powers and again at high powers. In the mid-range of laser powers, no evidence of shrinkage pores was observed.

Joint profiles visible with the naked eye were confirmed by metallurgical examination. At low powers, figures 5a and 6a, incomplete melting and poor wicking were also confirmed. At higher

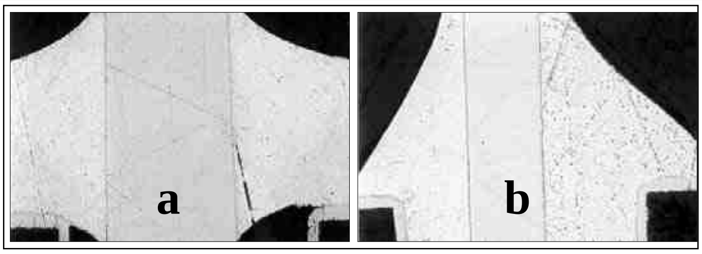


Figure 5. SnAg, 0.8 s pulse, X 50 magnification
(a) 6 W power. This confirms a poor joint with no 'wicking' down into the through hole.
(b) 10 W power. This shows a close to optimum joint profile with a good homogeneous grain distribution.

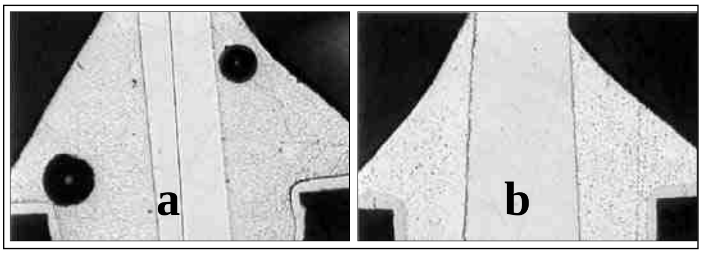


Figure 6. PbSn, 0.8 s pulse, X 50 magnification
(a) 6 W power. Significant porosity was visible in many of these joints produced at low power. There is also evidence of poor wetting of the internal hole diameter.
(b) 8 W power. This joint appears to be close to optimum parameters for PbSn composition.

laser powers, the visual evidence of local overheating of the flux was supported by the presence of porosity within the joint.

Examination of large numbers of joints identified a significant increase in grain size with average power for both solder compositions. Control of grain size holds out the prospect of optimising the mechanical properties of joints while at the same time conforming to upcoming legislation on reducing lead usage. It is expected that these advantages can be read across to a range of solder compositions.

In the case of the SnAg joints, a very good homogeneous grain structure was noted at the mid range parameters. This optimum in microstructural homogeneity was not noted in the PbSn joints. Similarly, for both compositions, mid range parameters showed good well-wetted interfaces between the solder and the pins and between the solder and the walls of the through holes. There is good evidence that the optimum power is slightly higher for the SnAg solder, this is only to be expected because of the 38°C higher melting point of the lead free solder.

Conclusions

Direct diode laser solder joints of high-quality and visibly and metallurgically sound were produced successfully in both lead-free and lead-containing solder. The use of a lead-free solder required higher energy input to achieve optimised joints but direct diode laser soldering of lead-free solders is certainly no more difficult than soldering lead-containing solders, but in both cases consistent and accurate control of output power, such as that provided by direct-diode laser systems, is required to achieve consistently high joint quality..

The authors would like to acknowledge the help of Paul Crittenden for the preparation of the samples and photographs. *This article is based on a paper presented at the ICALEO Conference (Jacksonville, FL. USA 15 - 18 Oct. 2001). and is published with the kind permission of the Laser Institute of America.*

The new laser hazard classification scheme

Mike Green
Pro Laser Consultants
100 Ock Street Abingdon Oxon OX14 5DH
T: +44 1235 550522 F: +44 1235 550499 E: mike@prolaser.co.uk

The classification scheme below applies to all laser and LED sources.
It came into effect on 1 January 2001 with the issue of EN60825-1:2001.

Class 1
No risk to eyes or skin

Class 1 laser products are defined as safe in normal operations under reasonably foreseeable conditions, including direct viewing of the laser beam with optics that could concentrate the laser output into the eye. In addition to some intrinsically low power lasers and laser products, Class 1 laser products also include embedded products that totally enclose a higher Class of laser e.g. CD players, laser printers and most industrial laser processing machines.

Lasers that were Class 1 under the previous version of 60825-1 remain Class 1 under the new scheme.*

Warning label: none

Class 1M
Low risk to eyes. No risk to skin

Class 1M laser products are defined as safe in normal operations under reasonably foreseeable conditions, including direct viewing of the laser beam, but only provided the user does not employ optics that could concentrate the laser output onto the eye. Unsafe conditions include use of a telescope or binoculars with a 1M laser emitting a well-collimated laser beam or use of an eye loupe or magnifier with a high divergence 1M source.

1M can only apply to lasers emitting in the wavelength range 0.3025 to 4 µm. Class 3A lasers emitting invisible radiation now become Class 1M.

Warning label: LASER RADIATION. DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS

Class 2:
Low risk to eyes. No risk to skin

Class 2 laser products are defined as those emitting visible light for which the natural aversion response to bright light (including the blink reflex) prevents retinal injury, including direct viewing of the laser beam with optics that could concentrate the laser output into the eye. These lasers do, however, present a dazzle hazard.

Lasers that were Class 2 under the previous version of 60825-1 remain Class 2 under the new scheme

Warning label: DO NOT STARE INTO BEAM

Class 2M:
Low risk to eyes. No risk to skin

Class 2M laser products are defined as those emitting visible light for which the natural aversion response to bright light (including the blink reflex) prevents retinal injury for direct viewing of the laser beam but, as with Class 1M laser products, only provided the user does not employ optics that could concentrate the laser output onto the eye.

Class 3A lasers emitting visible radiation (wavelength range 0.4 to 0.7 µm) now become Class 2M.

Warning label: DO NOT STARE INTO BEAM OR VIEW DIRECTLY WITH OPTICAL INSTRUMENTS

Class 3R:
Low risk to eyes. Low risk to skin

Class 3R laser products are defined as those for which the output is up to a factor of five over the maximum allowed for Class 1 or Class 2. Because of safety factors built into the limits for these classes, the risk of injury for direct viewing of a Class 3R laser beam remains low, but greater efforts should be taken in the use of these lasers to prevent direct eye exposure, especially for invisible Class 3R lasers.

Visible 3R incorporates many of the USA IIIa lasers and the so-called '3B-star' Class of laser.

Warning label: For laser wavelengths in the range 0.4 - 1.4 µm: AVOID DIRECT EYE EXPOSURE. For other laser wavelengths: AVOID EXPOSURE TO THE BEAM

Class 3B:
Medium risk to eyes. Low risk to skin

Class 3B laser products are defined as those for which direct exposure of the eye is hazardous, even taking aversion responses into account, but scattered laser light is usually safe. The higher power Class 3B lasers are also a skin hazard, but the natural aversion response to localised heating generally prevents a skin burn.

Some lasers that were Class 3B under the previous version of 60825-1 may now become a lower Class, particularly if they have output beams that are either highly divergent or of large diameter,

Warning label: AVOID EXPOSURE TO THE BEAM

Class 4:
High risk to eyes and skin

Class 4 laser products are defined as those for which direct exposure of the eye and skin is hazardous and scattered laser light may be hazardous to the eyes. Such lasers are also a fire hazard.

Lasers that were Class 4 under the previous version of 60825-1 remain Class 4 under the new scheme.

Warning label: AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION

** For laser wavelengths in the range 0.4 to 1.4 µm, the Accessible Emission Limit for Class 1 has increased by 78%, thereby pulling in some lasers previously of higher classification.*

Meetings

Highlights

Photon 02

Billed as ‘The UK’s premier event in optics and photonics’, Photon 02 will bring together at a conference and exhibition those working in academia and industry, covering basic and applied research, industrial implementation and exploitation. The organiser – the United Kingdom Consortium for Photonics and Optics (UKCPO) – has available a wealth of experience from its member organisations. The result is a programme that covers the latest technology as well as the latest research. The two main strands are the Industrial Technology Programme and the biennial conference of the Applied Optics Division of the Institute of Physics. In addition, the Photonex exhibition will provide networking opportunities for the community with ‘Meet-the-Buyer’ surgeries, a Recruitment Fair and a Technology Transfer Forum.

ICALEO 2002

General Chairs: Eckhard Beyer (Fraunhofer Institute for Material and Beam Technology, Dresden Germany) and Rajesh Patel (IMRA America Inc, Fremont, California, USA)

The International Congress on Applications of Laser and Electro-Optics (ICALEO®) has a 20 year history as the conference where researchers and end users meet to review the state-of-the-art in laser materials processing and predict where the future will lead. From its inception, ICALEO® has been devoted to the field of laser materials processing and is viewed as the premier source of technical information in the field. Each year ICALEO® features areas of topical automotive, aerospace, electronics, bio-medical and microfabrication fields.

AILU events

Attentive delegates at the ‘Tricks and Secrets’ meeting in Bristol

April

10 Developments and Trends in Industrial Laser Use

AILU Members’ Meeting including ‘The Industrial Laser Market’ forum discussion, ‘What’s New in 2002?’ commercial review, ‘Spotlight on laser-based manufacture’ presentation, AGM and factory tour.
Spectron Laser Systems Ltd, Rugby
Contact: AILU Office
New!

23 ICCT 2002 etc. (23 & 24)

International conference on cutting technology
Dorint Hotel, Hannover
Contact: Kontec
T: +49 (0) 40 527 48 28

29 MACH 2002 etc. (29 April - 3 May)

MACH, Metalwork, Welding & Metal Fabrication, Automation & Robotics and Engineering Lasers
AILU-supported event*
NEC Birmingham
Contact: MTTA
T: +44 (0) 20 7298 6400
E: metalworking@mtta.co.uk
** visit the AILU stand in Hall3 (Stand 3049)*

June

Millimetre-scale processing: the laser advantage

AILU Technical Workshop
Day and Midlands venue TBA
Contact: AILU Office (flyers not yet issued)

September

3 Photon 02 (3 - 6)

Exhibition, Conference and Industry Technology Forum
AILU supported event
Cardiff International Arena
Contact: Institute of Physics
T: +44 (0) 20 7470 4926
E: enquiries@ukcpo.org
New!

11 New trends in Laser Welding

AILU Technical Workshop and Exhibition
TWI Ltd, Cambridge
Contact: AILU office (flyers not yet issued)

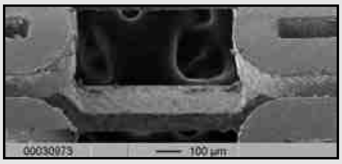
November

14 ICALEO 02 (14 - 17)

International conference on laser materials processing
Scottsdale, Arizona USA Contact: AILU
Details at *http://www.icaleo.org*

Contents

IN THIS ISSUE



Medical applications of fine cutting p 32

Material costs p18

Spinning laser beams p24

Manufacture by laser-based lithography p35

Flexure options p30

Quality soldering with diode lasers p36

Laminated tool manufacture p27

Editorial Policy

The Industrial 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, in part or in whole, their material for future use.

'The Industrial Laser User' is published quarterly by the Association of Industrial Laser Users and distributed for its members only.

The Industrial Laser User
Editor: Mike Green
ISSN 1366-963X

AILU, Oxford House, 100 Ock Street, Abingdon, Oxon. OX14 5DH
T: +44 1235 539595 F: +44 1235 550499 E: admin@ailu.org.uk