The Industrial LASER USER

association of industrial AILU laser users

Issue 29 December 2002

Taking the laser message to designers

Tim Weedon reflects on a meeting to sow the seeds of a new AILU initiative

The members'-only meeting 'Design for Manufacture and Reliability' at Loughborough University on 21 November 2002, provided an opportunity for members to learn about engineering design issues and to participate in the planning of a new initiative within AILU to raise awareness of the potential role of laser technology in manufacturing.

It is very easy to think that the formal approaches to Design for Manufacture and Assembly (DFMA) and Reliability Engineering apply only to mass-produced products but in fact we saw, through the presentations, that there are lessons to be applied even to one-off products. We saw too that there is the opportunity for a constructive interplay between the requirements for manufacture and the requirements for reliability; unusually, both sets can be met without a compromise.

Ian Bettles, Programmes and Development Director and Executive Director of Smallpeice Enterprises opened the presentations with a talk on Design for Manufacture. The effect of Ian Bettles' charismatic approach was enhanced by the challenges of the case studies he gave us. I guess that I was not the only member of the audience who thought more than once "Oh my goodness, I have made that mistake". We also carried away a number of clever tricks to be used in future, as well as an interest in learning more about the formal tools of DFMA.

The presentation 'Design for Manufacture: the Laser Dimension' by Christoph Gerritson (TWI) reviewed the requirements and the flexibility of laser welding from a manufacturing engineer's viewpoint, and will have helped practitioners to see their own knowledge in perspective. For those who are experts in cutting or drilling but have no experience of laser welding, it was a useful 'peep over the fence'.

Speakers at 'Design for Manufacture and Reliability'. (l to r) Stuart Sutcliffe (BMT Design Consultants), Christoph Gerritson (TWI), Ian Bettles (Smallpeice Enterprises) and Tim Weedon (Chair)

To convey the essence and potential of Reliability Engineering in a single lecture is a challenge indeed. Stuart Sutcliffe, Principal Consultant and Manager of Design Safety and Reliability at BMT Design Consultants Ltd, gave us a tantalising glimpse of this discipline which, despite its lack of glamour, has so much to offer to process and product development alike.

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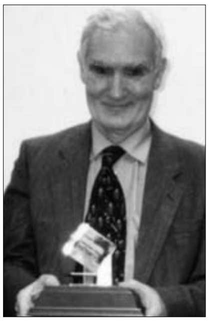
AILU Awards for 2003

Each year AILU seeks to make an award to recognise 'an individual who has made an outstanding contribution to the industrial use of lasers in the UK'. This individual will, probably over a period of many years, have substantially advanced the effective development, application or adoption of industrial laser technology and the award may well come late in their career.

At this year's AGM we presented our first 'Young Engineer's Prize', a new initiative to help encourage young people in the UK to expand their interests in the development of laser applications. The Prize is awarded on the basis of the economic gain and wider benefits of a single piece of practical or academic work.

Presentations of the 2003 Award and Prize will take place during the AGM at Jaguar's Castle Bromwich Plant, Birmingham on 9 April.

Send your nominations to *awards@ailu.org.uk*. Full details will be sent out in the New Year.



Most recent winners. (left) David Dyson receiving the AILU Award 2001 and (right) Emma Johnston receiving the Young Laser Engineer Prize 2002

Job Shop meeting success

By all accounts the Laser Job Shop 02 event at the Hilton Hotel, Coventry on 29 October was a great success.

By way of introduction to this afternoon meeting, Job Shop chair David Lindsey encouraged job shop representatives among the 50 plus delegates to give a brief introduction to their company and to highlight the greatest challenge they faced at the present time. The consensus of those present was that low margins was by far the biggest challenge (several mentioned 'suicide pricing'). Competition was second and problems of recruitment (of skilled and motivated machine operators in particular) was third.

On the issue of margins, job shops expressed increasing concern at the tactics employed by purchasers in their attempts to squeeze the lowest price out of the sub contractor. 'Lean manufacture', a favoured buzz word, is often synonymous with allocating less to supply chain purchases. The Chairman David Lindsey suggested that, as a group, 'perhaps we should bite back and offer to sit down with management and see how costs could be reduced in other ways, such as by improved product design.'

The two invited presentations were particularly well received by the delegates. In his presentation 'The current economic climate in the UK manufacturing sector' Geoff Noon of the Machine Technologies Association (MTA, formerly the MTTA) pointed out that in economic terms the UK is a 'global star'

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Letter to the editor

Pitfalls of free-issue material

The article by John Powell on this subject (Issue 28, p22) has brought into focus a very thorny issue as far as my company is concerned. I am too embarrassed to let you print our identity but feel strongly enough to share our bruising experiences with fellow readers and perhaps most importantly, our solution to the issue.

The situation almost always involves (i) expensive material, (ii) an element that, without care, can catch you out and (iii) when it goes wrong, a totally intransigent customer. Do not expect a customer to be interested in your ‘Condition of Sales’. Trying to argue “We only cover the cost of our invoice” gets you nowhere.

We have had several such experiences. The first, some years ago, involved large components cut from plastic coated polished stainless steel. The components were left and right-handed only differing by 1 hole in each. Unfortunately, we cut them the wrong way round, i.e. coating and polishing on bottom face, not the top as required. I could go into the poor drawings, the difficulty in deciphering which hand was what, but the bottom line was they were incorrect to our customers requirements!

No problem we thought, we could get them re-polished on the ‘right’ side and salvage them. Not that simple! The polishing was very special, the grit and graining needed to be just so! OK, what about cutting the hole in one part and at least saving them - not acceptable as they must match exactly on the polishing! OK, OK, accept defeat! Simply buy replacement material and cut the job again? You’ve guessed. Not that easy, the sheet size was specially decoiled and the polishing could only be done by one company in the UK! - NET RESULT - serious time delay in obtaining material, material nearly twice the price expected and, worst still, a very unhappy customer; sorry, ex-customer! Not to mention the actual cost to us!

Just one more example. We undertook to cut a formed component just on our cutting thickness limit for a subsidiary of a regular customer. Unfortunately the cut quality was bad so we spoke to the customer and they said they would ‘probably get away with it’. The invoice addressed to the regular customer was very quickly returned stating that it had nothing to do with them and should be sent to the company that ordered the parts.

Needless to say, the parts were unacceptable, they could not ‘get away with it’. I received a letter informing me that the customer expected us to foot the bill for replacements, including new parts and various work they had completed before they decided the parts could not be used. The letter stated that we were lucky not to be sued for further costs due to the delicate situation we had caused with their customer. The costs involved? Seven times our cutting charge!

One final sting in the tail! The regular customer deducted this amount when paying his account shortly after we received the subsidiaries reject letter! Funny that!!! Also, we have not been able to obtain the rejected parts! Funny that too!

What lessons have we learned from our experience?

a) Contract Review at top level ANY free issue work.

b) Always obtain the value/availability of the Material/Parts involved.

c) Assess the risk of processing, i.e. difficult or thickness of material/equipment capability.

d) Assess the risk of cost of processing/material value.

e) Assess the risk of complete success - profitable completion for both parties.

f) Prepare quotation to allow fully all costs involved including supervision, QA and management time needed to obtain a 100% satisfactory job.

g) Finally - State clearly on your quotation your conditions regarding free issue material/parts and replacement should the unfortunate happen.

I hope this letter encourages others to express their experiences.

Yours sincerely

A chastened job shop owner

Note from the editor

December is a month where many of us will take the opportunity of what is generally a quiet business period to try to clear our desks in preparation for the new year ahead. And despite not wanting to think too much about 2003 just yet, I must say that a workshop on rapid manufacture in March and a members’ meeting with a tour of Jaguar in April are certainly worth planning for, and this is just the start of what looks like being our busiest year yet.

‘Rapid manufacture’, the technology of late time customisation, high throughput, productivity and flexibility, is one where lasers have a key role to play. Techniques include high speed cutting and direct metal deposition, the latter being increasingly regarded by many as ’the next big laser application’. Take a look at Hugh Bisset’s paper in this issue, for example.

Tooling repair by direct metal deposition is already a well established application and one could not ask for a bigger success story for this technology than that described in Trevor Anderson’s paper on laser cladding, a paper that in the opinion of at least one of our members, stole the show at ICALEO. It would seem that business opportunities abound for people with conviction and the courage to ‘think laser’!

It is intriguing to reflect on the fact that the first application of laser cutting was in the manufacture of die boards and that laser-based technology has reached the point where we now have direct metal deposition as an attractive alternative means of manufacturing dies and high speed laser cutting as a technology that might well replace dies in some applications.

There is no doubt that we all deserve a good break this Christmas. 2002 has been a difficult year for the manufacturing sector worldwide and the forecast for 2003 is not particularly encouraging. However, the longer term future remains excellent for laser-based manufacture, and I would like to think that this is reflected in the fact that whereas many associations have suffered a significant decline in membership in 2002, AILU ends the year with membership at an all time high. So, from all of us at the AILU office, have a happy and restful festive season.

Letters (continued)

LSO training and certification

I read with interest your question and answer on 'Do I need a laser safety officer?' (Issue 28, p25)

Training requirements for a Laser Safety Officer may not be strictly specified in the UK but they certainly are in West Australia, where the Radiological Council sets a formal LSO examination. As a laser job shop owner I have undertaken the training and passed the examination, which I think you will agree (see the sample paper below) is no small achievement!

The Radiological Council requires that a LSO must be present when Class 4 lasers are in use and that such lasers can only be maintained by an LSO if he or she has achieved a "service endorsement" in their exam, which requires a mark of 84% or more. As you can imagine, this requirement becomes a major headache if a machine breaks down and needs servicing when I am away from the office.

I am in the process of training up some of our senior laser operators for LSO certification, but I think that your readers will agree that the sample examination question below goes well below what is needed for a LSO in a job shop setting and implies a theoretical understanding of laser safety that effectively excludes many highly practical individuals who would make excellent LSOs but who lack the academic background.

I would like to think that job shops in Australia could unite and bring pressure to bear on the relevant authorities to adopt a more realistic and flexible view of laser safety in the job shop environment. To this end, any comments from your readers would be greatly appreciated. Meanwhile, I would be very interested to know how many of your readers who are LSOs feel that they would make the grade in Australia!

Yours sincerely

Jay MacFarlane
Laser and Allied Cutting Services, Perth, West Australia

SAMPLE EXAMINATION

Radiological Council Laser Safety Examination (Industrial)

Instructions

All questions must be attempted. This is an OPEN BOOK examination.

Total marks: 100. A pass mark of 65% is required for this paper. To be appointed as a Laser Safety Officer, a mark of 75% is required

1. Classify the following lasers. Note that unless otherwise stated or implied, each laser is a continuous wave (CW) type and the beam is well collimated with a diameter of 3 mm.
   i) 5 mW Nd:YAG laser of wavelength 1.08 mm (2 marks)
   ii) 40 mW He-Ne laser of wavelength 632.8nm (2 marks)
   iii) 100 W CO_2 laser of wavelength 10.6 mm (2 marks)
   iv) 0.97 mW He-Ne laser of wavelength 632.8 nm (2 marks)

   For the following, show all working:

   v) 1 mW Argon laser of wavelength 351.1 nm (3 marks)
   vi) 2 mW diode laser of wavelength 670 nm (3 marks)
   vii) the laser in (i) above, with an optically modified beam diameter of 1.5 cm (3 marks)
   viii) a frequency doubled Nd:YAG laser (532 nm wavelength) with an average power of 2mW for a pulse duration of 100 µs and a pulse repetition rate of 1 kHz. (3 marks)

2. Which of the lasers in Question 1 are:
   a) considered "inherently safe"? (2 marks)
   b) a potential fire risk? (2 marks)
   c) considered to be "effectively safe" because of the blink reflex of the eye? (2marks)

3. Answer the following:
   a) Which Classes can apply only to visible lasers? (2 marks)
   b) Differentiate between the power and the power density of a laser beam. Illustrate your answer with an example. (8 marks)
   c) What is the significance of the "< 25 W.m2" proviso in the definition of a class 2M laser? (8 marks)

4. What is meant by:
   a) specular reflection? (4 marks)
   b) diffuse reflection? (4 marks)
   c) which of these is of more concern and why? (2 marks)

5. Answer the following:
   a) What parts of the body are most susceptible to laser injury? (2 marks)
   b) Describe the types of injuries that can occur and in particular relate them to the wavelength and power of a laser and the exposure time. (20 marks)

6. You are in charge of laser safety in a factory that has a number of lasers installed and normally operating. Briefly describe the safety precautions that you would be required to take with each of the following lasers:
   a) A laser doppler anemometer employing a 2 W visible (green and blue) Argon laser that is used for measuring gas flows in a test engine (4 marks)
   b) A 100 mW Ga-As diode laser source that is normally in a sealed enclosure and coupled to a single mode optical fibre line. This system is used for product testing in the factory laboratory. (4 marks)
   c) A 3 kW CO_2 flatbed cutting laser machine in the main factory area. The machine is open topped and there are gaps in the guarding at the back of the machine at table level to facilitate the operation of a pallet changing device. (4 marks)
   d) A 1mW visible diode laser that is used for alignment of machine parts in the factory area. (4 marks)

7. Map out a set of appropriate safety precuations that apply to:
   a) the Argon laser described in part (a) of question 6 above. (5 marks)
   b) The Ga-As diode laser system described in part (b) of question 6 if the system is to be regularly disassembled. (3 marks)

END

New opportunities for laser welding of metals

Over 50 delegates attended the AILU workshop 'Laser welding of metals: new opportunities', which was held on 11 September 2002 at the TWI Conference Centre, Cambridge. In his introduction to the meeting, Paul Hilton, Technology Manager at TWI, noted that 'It does not seem very long ago that a meeting on high power laser welding would have addressed anything other than the use of CO_2 lasers, focused to a simple symmetric spot. Today, however, as well as the CO_2 laser, we must also consider: the rapid developments in both the high power direct diode lasers and in the cw and modulated Nd:YAG solid state lasers; the benefits of bringing the beam to a focus that is not a simple, circularly symmetric spot; and laser beams combined with electric arcs in a hybrid welding method that overcomes the otherwise tight tolerance to joint fit'.

Speakers at the 'Laser welding of metals' workshop.
(l to r) Wolfgang Gref (IFSW Stuttgart, Germany), Martin Bea (Trumpf Lasertechnik, Germany), Paul Hilton (Chair), Mo Naeem (GSI Lumonics), Clint Wildash (Corus), Mark Cole (BOC), Frank Roland (German Shipbuilding Research Centre and Meyer Werft, Germany), Friedrich Bachmann (Rofin-Sinar, Germany) and Simon Hargrave (Laser Optical Engineering). Missing is Geert Verhaeghe (TWI)

What followed was an exciting update since the previous AILU workshop on high power laser welding some four years ago, on the great strides that have been made in the industrial acceptance of the process for flexible, high quality, low distortion joining.

Opening the formal presentations, Geert Verhaeghe of TWI introduced hybrid laser-arc welding, a technique that has been understood in principle for many years but has only relatively recently been exploited in earnest. He explained how, compared to pure laser welding, the hybrid process vastly improved tolerance to joint-gap (up 30 - 50%), increased welding speeds (up 40 - 100%) increased weld penetration (up to 50%) and improved weld quality. A number of case studies were presented, including welding of pipelines (see below) and sandwich panel manufacture in shipbuilding. The latter theme was taken up by Frank Roland of Meyer Werft and the German Shipbuilding Research Centre, Germany, who showed some truly impressive pictures of laser welding on a large scale. Clint Wildash of Corus presented results of 'dual process' and hybrid welding, including results using the 25 kW CO_2 laser facility at their Scunthorpe works (see paper 'Arc assisted high power laser welding of steel' in this issue).

Martin Bea of Trumpf addressed a range of dedicated tube and profile welding applications including machines for the continuous welding of stainless steel tubes and the welding of aluminium profiles. He described, for example, how laser welding of roll-formed stainless steel (and titanium) tubes provides high quality seams that are oxide-free, of excellent mechanical stability, and which maintain the corrosion resistance of the alloy i.e. no elemental segregation effects. Laser profile welding is widely used for the fabrication of such components including extruded aluminium profiles on a wide range of products. There are currently two Trumpf profile welding installations in the UK, one for the production of window spacers and the other for civil engineering components.

Mo Naeem of GSI Lumonics concentrated on Nd:YAG laser developments for welding and in particular the application of super-modulation (i.e. pulse shaping imposed onto an otherwise cw output) to provide peak powers up to 2.5 times the mean power in square or sine wave modulation. Results presented showed that, compared to cw laser welding, super-modulated sources achieved significantly greater weld penetration (but with reduced heat input), higher welding speeds, better plasma suppression, improved performance on aluminium alloys and other high reflective materials and increased depth of focus. Significant improvements were also claimed for laser cutting with a super-modulated output.

Turning to welding improvements by beam manipulation, Wolfgang Gref of IFSW Stuttgart described significant improvements achieved by using double focus and multi-focus Nd:YAG beams, including the diode-pumped thin disk laser (see paper 'The thin disk laser – a high precision welding tool' in this issue). Using a range of examples of work undertaken for the automotive and aerospace sectors, results showed greater weld bead stability (especially important in welding aluminium) with dramatically reduced porosity and increased welding depth.

Diffractive optical elements offer the possibility of tailoring intensity distributions to process, material and geometry and Simon Hargrave of Laser Optical Engineering described how they have successfully produced kinoforms to generate laser profiles for welding, resulting in improved grain structure.

Direct diode laser welding was described by Friedrich Bachmann of Rofin-Sinar. This radically different laser source is not well suited to keyhole welding, though this can be achieved with modern multi-kW sources. Cosmetic (conduction) welding is a major application area (examples of tube, heat exchanger and kitchen sink fabrication were provided) and a variety of other component joining applications were presented where direct diode welding has significant advantages over MIG and MAG alternatives

Finally, Mark Cole of BOC presented the latest results of the work carried out in their collaboration with BAE Systems on laser weld distortion control by cryogenic gases. (See 'Control of weld distortion by thermal tensioning' in Issue 25.) The use of CO_2 snow as a coolant reduces or eliminates longitudinal and transverse distortion, weld microstructures can be altered and weld spatter and weld appearance improved.

Paul Hilton deserves special thanks for organising such an interesting event, including a lively lunchtime exhibition with thirteen exhibitors, and a fascinating tour of the high power laser facilities in the new building at TWI.

Taking the laser message to designers

Continued from p1

It was valuable to hear the formal definitions and relationships of terms (including Reliability, Failure, Failure Rate, MTBF, Availability, Risk, Useful Life) that we tend to use everyday without enough thought. It was thought-provoking to realise that many consequences are far from intuitive, such as that after a time equal to the MTBF, a component's reliability is 37% and that if a component has an MTBF of 5 years, there is an 18% probability that it will have failed at the end of the first year. Stuart also introduced us to the concept of HALT (highly accelerated life tests), new to many in the audience and a potential route to eliminating failure processes early in a product development.

Interesting common themes flowed from the presentations:

- huge benefits accrue from sitting down at the start of a design project and defining the reliability and manufacturability requirements of a new product;
- formal tools exist and can be applied easily after training.

Following the formal presentations, a vigorous discussion considered what should be AILU's involvement in assisting members to improve competitiveness through the application of the tools.

The over-riding issue for job-shops is their isolation from the designers of the products they are processing. This isolation results from the formal barrier imposed by company purchasing departments. It is easy to understand how and why this isolation occurs, given the way the performance of purchasing agents is measured. However, it militates against continuous improvement.

The perception is that many designs are made with a lack of knowledge of the strengths and weaknesses of the manufacturing process options, and drawings are sent to vendors for quotation to manufacture without specifying process; the purchase decision being made on price. For example, rounded corners can reduce the processing time and cost of laser cut parts but there seems no means of getting this suggestion to the design authority.

A tentative conclusion was that a proactive approach to designers and designers-in-training was needed. The big, unanswered, question was how could AILU achieve this given our limited financial and human resource. Comments and ideas discussed included:

- Recognising that laser suppliers and job-shops already try to educate and train, AILU should consider how it might be able to produce aids and tools to help them.
- We must provide information and education in exactly the form that designers need it; this usually means using an electronic medium, either the internet or CD-ROM. This could exploit the AILU web site and web-based initiatives;
- It is difficult to identify and target designers, but design magazines appear successful. Adverts in such magazines, pointing to the AILU web site could be a very effective but expensive approach;
- We should raise awareness of the use of lasers in manufacturing, including: working with other associations and societies, especially engineering institutions; lobbying for inclusion of laser processing in the (company and university-based) training of all engineers; collaborating with events (including Make It With Lasers) aimed at design and production engineers; inviting designers into job shops to see laser processing in action.

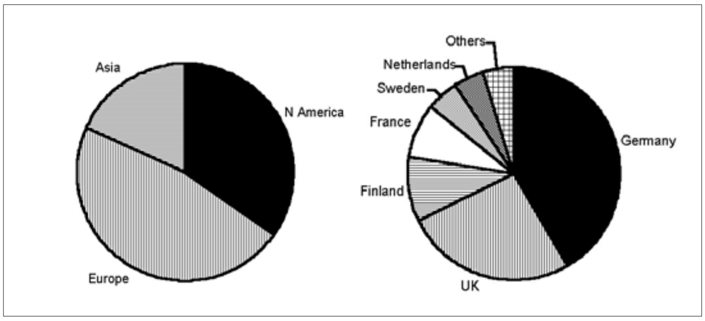
It seems likely that an AILU Special Interest Group, perhaps with special incentives for non-users of lasers, will be established to implement some of these ideas, though how quickly we could grow a new initiative and whether we can make an early impact remain to be answered.

ICALEO 2002: a truly international event

The International Congress on Applications of Lasers and Electro-Optics (ICALEO) held in Scottsdale, Arizona, 14 to 17 October attracted near record attendance and was a great occasion for meeting old friends and making new ones. The conference is a truly international event, with about 30% of the almost 500 laser industry professionals and student delegates travelling in from 25 countries with large delegations from Germany, Japan, Canada, the UK, France and Finland.

The technical sessions contained about 200 papers and the poster presentation gallery had more than 30 entries. Almost half of the authors of papers presented at the conference were from Europe, as shown in the graphs opposite. Of the 19 AILU members that attended, 15 were authors presenting between them 25 of the 208 papers. This included an acclaimed plenary presentation by Paul Hilton titled "In the beginning", a development of his AILU talk about the invention and development of gas-assisted laser cutting by Peter Houldcroft.

The UK was also well represented amongst the LIA's Awards this year. First place in the student paper award was given to Jose Greses of University of Cambridge, for the paper "Attenuation Under High Power Nd:YAG Laser Welding", J Greses, C Y Barlow, P A Hilton, W M Steen. Third place went to Stuart Edwardson of University of Liverpool, for the paper "Strain Gauge Analysis of Laser Forming", S P Edwardson, K G Watkins, G Dearden, P French, J Magee. The poster presentation award also went to a UK researcher, Andrew Pinkerton of UMIST, for the paper: "An Experimental and Theoretical Analysis of Axial Powder Stream Concentration in the Coaxial Direct Laser Deposition Process", A J Pinkerton and L Li.



Author affiliation of papers presented at ICALEO in 2002, viewed by geographical location. (left) division by global area, showing Europe with the largest share and (right) European contribution viewed by country, showing Germany accounting for approximately 40% of the total

Tim Weedon

Note: The ICALEO® 2002 proceedings, which contain all of the presented papers including the plenary session, are now available on CD-ROM. AILU members pay the LIA member rate of $165 and orders can be placed online at www.laserinstitute.org

European laser networks move forward

The 3rd international experts meeting of EU 2566 'European Laser Network (EULASNET)' was held at the EUREKA secretariat in Brussels on 7th and 8th November 2002 primarily to review running laser-based EUREKA projects and to help generate new projects by presenting prospective partners and discussing project suggestions. The DTI has provided a 3-year contract for AILU to provide a UK presence in this activity.

Participation in EUREKA projects

EULASNET offers the opportunity for any organisation interested in participating or leading a EUREKA project involving laser technology, to present information through their national contact person. AILU members presented at the recent meeting were: Liverpool University (high power lasers, high speed cutting and rapid prototyping); Lairdside Laser Engineering Centre (suite of laser processing machines); Institute of Photonics (semiconductor and ultrafast laser development); Sussex University (laser micro-engineering facilities); UMIST, Laser Processing Research Centre (high power diode laser applications, laser drilling, rapid prototyping and surface treatment)

By definition, EUREKA projects are closer to the market than the collaborative projects funded centrally by the EU Commission. Each member of a EUREKA project is funded directly by the national government and participation in a EUREKA project is no guarantee that funding will be forthcoming. Since 1992, the level of funding of UK participants in new projects in the laser-based manufacturing sector has remained low but there are rumours that more money may soon be made available for UK participation in manufacturing-related EUREKA projects.

The new 'umbrella' project

EULASNET is an 'umbrella' project linking individual EUREKA projects. It was established in March 2001 with a grand aim 'to provide a platform to stimulate research, development and technology transfer dealing with laser and optics technologies and their applications, in order to initiate projects emphasising market-driven co-operation between industry, research institutions and universities.' As a route to achieving this aim EULASNET would like to establish an active network comprising research institutions, universities and industrial users. Particular emphasis is placed on stimulating the growth of new laser-based projects involving the Central European countries now in the accession phase to join the EU within the next few years. Many new projects will undoubtedly develop to speed the integration process through the transfer of science and technology, education and know-how. This will be achieved through demonstrations, applications and the creation of new companies, joint ventures, etc.

European networks

The 1980's and early 1990's were the heyday of overtly laser-based EUREKA and EU Commission-funded projects. One major benefit of these projects was to force collaboration between organisations that were active in laser technology and applications and as a result many strong links were formed and several informal yet effective laser networks were established. The last of the big EUREKA laser projects, EU 643 'Safety in the Industrial Application of Lasers', ran from 1992 - 1997 and involved over 100 organisations spread across Western Europe. During this period there was much talk of establishing a European laser network and in 1996 ELAN (European Laser Applications Network) was formed. ELAN was envisaged as a 2-tier network in which international communication would be between national or regional 'nodes' i.e. administration centres that could act as impartial conduits for passing requests for products, services, project partners and/or technical information to and from industrial and academic organisations. At the time, only AILU and the CLP in France filled the role of a national 'node' and participated with a number of individual research centres around Europe.

Delegates at the recent EULASNET meeting, held at the EUREKA Secretariat office in Brussels, line up behind the reception desk. The Bureau for International Research and Technology Co-operation (BIT) in Austria provides the Secretariat services. Philippe Loward, the project's founder, is front left.

ELAN remains an open and informal network (see the ELAN link on the home page of the AILU web site) but in the absence of any funding for a proper launch and the establishment of an administration centre, it has not been particularly active to date. However, positive support for ELAN was expressed at the recent EULASNET meeting and the network may have a role in a proposed European Laser Institute.

European Laser Institute

The driving force behind the European Laser Institute (ELI) is the co-ordination committee of the Virtual European Laser Institute (VELI), an initiative established in 2000 with EU funding. Its services are web-based and the VELI web site, which should go live in 2003, will offer a wide range of laser materials processing capabilities through its network of partners across Europe. Among this modest sub-set of the European laser community the VELI membership includes AILU members TWI, University of Liverpool and Lappeenranta University of Technology.

A tentative proposal to establish a federated European Laser Institute was raised at the EULASNET meeting and a joint meeting is scheduled for 18 December in Brussels to take matters further. Not everyone agrees that the formation of a full-blown European Laser Institute is a desirable or even a viable proposition, but the more modest goal of developing a platform to cross-link the various laser-based networks within Europe is within our grasp and would clearly be a worthwhile endeavour.

For more information from the internet, ELAN and EULASNET have direct links from the AILU home page *www.ailu.org.uk.* EUREKA information can be found at *www.eureka.be*.

Successful laser job shop meeting

(Continued from p1)

However, despite economic growth ahead of many other economies, stable low inflation and unemployment below the European average, we run a two-speed economy. Manufacturing output has shown little growth over the past decade (output is currently less than it was in 1995) while services output has grown steadily at around 4% per year. “The recession in industrial production is expected to end in 2003 but it isn’t possible to be very optimistic about growth in UK manufacturing output,” he concluded.

Points raised in discussion following the presentation, included:

- UK manufacturing has a particularly low ranking in terms of workforce productivity. A lack of training and motivation were to blame, brought about by the poor quality of management within UK manufacturing companies.
- Western European manufacturing industry is threatened by Eastern Europe, where labour costs are relatively low and the workforce is skilled and English speaking. To survive, UK companies must look to retaining high added value parts of the manufacturing process.

David Belforte began his laser work with the Ferranti 400W CO_2 laser, serial number 003, in 1971 (he noted that Dennis Kent of Carlton Laser Services has 001!) and has kept close ties with the laser job shop business ever since, most recently in his role as Publisher/Editor-In-Chief of ‘Industrial Laser Solutions’ in the USA. Having spent the day prior to this meeting touring UK job shops and talking to their owners, he was able to highlight several interesting differences between the US and UK industries during his presentation ‘The job shop market in the US – surviving a severe downturn’. Though he believes very much that job shops are very similar the world over (see David’s feature on p9), he pointed out that by comparison:

- There is much more ‘lights out’ operation in the USA, and (in direct contradiction to views frequently expressed within the Job Shop Group) there is little argument that this approach is highly reliable;
- Higher power lasers are being used in the USA. He added that there was nothing on show at the recent Euroblech exhibition at less than 4 kW and that where there are 2 kW lasers in US job shops, these were rapidly being replaced by 5 kW sources;
- Better, more extensive management and control software was evident in US job shops;
- Greater relative quantities of thicker material were being laser cut in US job shops
- A higher proportion of cut metal was stainless steel (25%!) and aluminium. However, nitrogen costs are significantly lower;
- There is much more cutting of non-metals in US job shops.

Other differences included the fact that Mazak is the main supplier of laser cutting machines in the USA and David’s impression, based on the responses during the meeting introduction, was that there were many more lasers per company for those represented at this meeting than the 1 - 2 laser average in the USA. In 2002, despite the poor state of the USA economy, about 100 new job shops opened, though many of these were former non-laser job shops that had decided to add a laser.

After the mid-afternoon refreshment break, John Powell of Laser Expertise presented ‘Results of recent AILU laser job shop surveys’ covering, in particular, the key results on pay and gas costs. Economic trend survey forms were distributed at the meeting and John encouraged greater job shop participation in this and the other 2002 surveys.

A review of leasing arrangements for laser machines was presented by Steve Gee of Close Asset Finance in his presentation ‘Laser machine finance – a new dawn?’ He was keen not to prescribe any one particular form of arrangement any encouraged job shop owners to ‘think outside the box’. He pointed out that there has been a rapid growth in the uptake of rental agreements but he acknowledged that rental didn’t suit everyone. Nevertheless, he suggested that it was worthwhile reviewing the financing options when considering major equipment expenditure.

Peter Charnley of RE Cooke completed the presentations with a talk on ‘Software lessons’ in which he very kindly shared with delegates what he now regarded as the ‘Nine Steps to Making the Right Decision’, learned the hard way from having gone through a difficult implementation of new software within his company. He stressed that none of his problems had been due to the software supplier, but were caused by the approach he and his colleagues had taken during the procurement process.

Nine steps to making the right decision in software purchase

Peter Charnley

1. Define what exactly you want the software to do. This could include one or all of: accounts, production, sales, purchasing, commercial, Q.A.
2. Research the market (Establish the systems currently available and match them to your needs. Draw up shortlist to investigate).
3. Arrange demonstrations. (These should reflect the “needs” that you have indicated to the software providers. Explain that there may be a second, more comprehensive demonstration).
4. At the demonstration: beware the sales pitch; beware of buying more than you need; discuss price.
5. After the demonstrations draw up a shortlist of 2-3 suppliers maximum and arrange more comprehensive demonstrations <u>using your own data</u>.
6. At the second demonstration: ask lots of “what if”, “how” & “why” questions; keep a focus on how the system measures up to your initial “wants” list; discuss price again! During the demonstration, cover: usability/versatility of the system; training packages; support services; list of other users in comparable industries (you need to take up references); can existing data be transferred electronically?
7. After the final demonstrations, if you don’t feel totally sure, don’t hesitate to start again. This is a big investment!
8. Once you’ve made your choice: time to negotiate price – expect to see a reduction!
9. In conclusion: decide on an implementation schedule; sort out revised forms such as invoices etc.; sort out training requirements; appoint someone to have responsibility.

Were We Mad?

Dennis Kent of Carlton Laser Services reflects on his 'lights-out' experience

Three years ago I looked at the concept of going "lights out", utilising a laser/punching cell. I believed there were real cost savings to be had that would make us more competitive. Most of my colleagues in the laser job shop community at that time thought we were mad and probably still do, but Pullmax/Bystronic thought otherwise.

Now, with 12 months of actual operation with a Bysprint laser and Pullmatic 6000 punch press linked to an 80 tonne capacity tower/store, I can reflect on the experience and say 'No, we were not mad!'

I accept that the benefits were not as clear cut as they may seem nor are we operating at as high a level of "lights out" as I would have liked, but we are learning all the time.

The system has forced new disciplines upon us, in as much that the tower requires accurate information. For example, the operator cannot simply just load a 2 tonne pack of, say, 3mm cold reduced steel sheet: the system needs to know exactly how many sheets are in the pack. However, once the information is entered then the system keeps a running inventory and it has the knock-on effect in tightening up our goods inward procedures.

The laser side of the operation performs well and very little bridging-in of components is required to prevent them tipping up and colliding with the head. The nature of the punching side of the work is very different; we restrict the punching to 1 to 3mm thick materials and so we have decided to leave components bridged in. Not a problem until the next morning when the cassettes within the tower have to be emptied and the punched work de-tagged (i.e. removed from the sheet)!

Given the right type of work, the system is very productive and although an operator can be removing work from the tower whilst the laser is cutting, we cannot do this with the punch. The pallet of punched sheets has to be removed as a pack from the machine and de-tagged elsewhere. To overcome this, an extra module, known as a part picker, can be added to the machine thus allowing virtually total unmanned running. Our initial belief was that we could handle the generated volume of de-tagging without a part picker, but we have since changed our minds.

We anticipated problems with the cell shutting (down due to a malfunction, programme error etc.) once the lights had been turned out, but experience is now showing this to be a low risk, though not so low it can be ignored.

The final phase of our project, space permitting, is to link a further laser to the cell. We shall see…watch this space!

Some comments on Job Shop '02

"A stimulating and worthwhile event and a 'must' half-day workshop for all laser job shop managers/owners in the current competitive environment." **Sean MacEntee** (Laserform (Irl) Ltd, County Louth, Republic of Ireland)

"The job shop 02 event was both enjoyable and interesting. I would certainly encourage those who did not attend to go to future ones. Not only were the speakers of a very high standard but the questions raised and comments generated among the delegates was too. The opportunity for informal networking between sessions was useful and I was grateful for the opportunity to bounce ideas off of colleagues in the industry." **Darren Kelly** (Drucegrove Limited, Waltham Abbey, Essex)

"The meeting was about laser job shops. Anyone serious about their business should attend: the benefits can be general, specific and unpredictable" **Simon Lau** (Lasers Are Us, Pyle, Cardiff)

"I thought it was a very worthwhile day. It is good to put a face to the competition and to appreciate that a competitor is not necessarily an enemy." **Robert Davies** (City Engineering, Bristol)

"The Job Shop day was a great success. It was encouraging to see so many new faces and many of the 'first timers' that I spoke to said they were pleased they made the effort to attend. From a selfish point of view I find that the Job Shop Group surveys are particularly useful. The more companies that add their data the more useful and accurate the result." **Neil Main** (Micrometric Techniques Ltd, Lincoln)

"The meeting was fun and informative.I really enjoyed the man from MTA - Excellent stuff! Needless to say, David's presentation was spot on too. There seems to be an awakening recognition that AILU can be as powerful and effective as its members choose to make it. I am hopeful that we'll get more active support after this meeting, to the benefit of us all."

Peter Charnley (RE Cooke & Son (Burton) Ltd, Burton on Trent))

The Job Shop Committee would like to thank
II-VI, Laser SOS and Pullmax
for their generous sponsorship of the Job Shop '02 event

Job shop committee activities

Thanks to a successful recruitment campaign over the summer, AILU gained 13 new job shop members in the run up the the Job Shop '02 meeting, raising the total to 52.

Following the first publication of the 'Table of flatbed laser cutting capabilities', distributed at Metalworking 2002 and in the October issue of Production Engineering, the job shop committee will be looking at other group advertising opportunities.

Three surveys have recently been circulated: (1) a Transport Cost and Service survey (new); (2) a Benchmarking Payroll and Materials Costs survey (new) and (3) the Satisfaction with Machine Service survey. Reports (sent to contributors only in the case of surveys (1) and (2)) will be distributed early in 2003.

The job shop committee members for 2003 are: John Bishop (The Cutting Edge), Peter Charnley (RE Cooke & Son), David Connaway (Cirrus Laser), Martin Cook (NG Bailey), Robert Davies (City Engineering), Ian Hayward (Metal Processes), Dennis Kent (Carlton Laser Services), David Lindsey (Laser Process), Sean MacEntee (Laserform), Neil Main (Micrometric Techniques) and John Powell (Laser Expertise).

New faces on the job shop committee.
(l to r) Ian Hayward (Metal Processes), Robert Davis (City Engineering) and David Connaway (Cirrus Laser)

UK job shops: a US perspective

David Belforte
Publisher/Editor-In-Chief, Industrial Laser Solutions, USA

Extracts from his extended article "It's the same the world over" ILS Global Report .

Through the offices of the UK Association of Industrial Laser Users Job Shop Committee I had the good fortune to visit three successful laser job shops located in the "Heart of England." These shops, arranged in a neat triangle just northeast of Birmingham, are headquartered in lovely rolling-hill countryside that, not too long ago, was part of Britain's mighty industrial engine. Today, driven by a diverse light-manufacturing industry sector, it is in the process of recovering from decades of economic downturn.

The point I've made in the past, that laser-cutting shops around the world are pretty much the same, is true, but this occasion allowed me to see subtle differences between these three shops. All three companies started as laser shops at least 20 years ago. That is, their only business was laser cutting, primarily of metals, a technology that got its start in the UK with the development of gas-assisted laser cutting of mild steel. Their current existence and state of success is a testament to the astuteness of their management and ownership.

Black Country

Laser Process Ltd (Cannock, Staffordshire) is in the process of moving into a new, purpose-built, 15,000 ft^2 building about a mile from its original home. The factory houses five Trumpf lasercutting systems, three Model 2530s, the first twin-head Nd:YAG cutter (HSL 2502) and a new 5 kW Model 3050.

Laser Process has an annual turnover of around $5 million and runs 24/5. A staff of 24 people keep orders flowing though the laser cutting machines on a three-shift-per-day schedule.

An in-house-developed order-processing program tracks orders and controls production. Mild steel is the dominant metal being cut, although the new Trumpf 3050, with a 5 kW CO_2 laser, is attracting more customers with stainless-steel orders, in thicknesses up to 15 mm. With ample floor space, Lindsey plans to add more laser-cutting capacity in the near future, leaning toward tube-cutting capability.

Robin Hood Territory

Laser Expertise Ltd (Nottingham) operates from a 10,000 ft^2 facility. The company operates four laser cutters, three of them from Bystronic and one an old system, built in-house, which is used for prototype work. A sister company, with fabrication, bending, and welding capabilities, occupies about a third of the facility, but is now being integrated into Laser Expertise.

Laser Expertise has an annual turnover in the $5 million range, done with 50 employees, about one-third of which work in the fab shop. Most of the cutting work is in mild steel, with stainless-steel representing about 10% of the cutting volume. Non-metals help to keep them cutting 24/6.

For the future, the company will add new, higher-power laser cutters, replacing the old as laser power continues to ramp up.

England's Heart

Leicester-based Carlton Laser Services (CLS) started life as a laser cutting shop 25 years ago with a Ferranti MF-400 and through the years has morphed into a single-source shop offering CNC punching, fabrication, finishing and quality control, in addition to running two Bystronic laser cutters. CLS is believed to be the only UK shop offering "lights out" cutting services. Like Laser Expertise, CLS has another company, Peachmay Sheet Metal Ltd that provides fabrication and finishing services.

With 55 people CLS runs 24/5 and turns over about $6 million per year from a 17,000-ft^2 facility. A Radan software system controls order and production flow. Future expansion will include an automatic parts-retrieval systems and a higher-power laser cutter. CLS recently installed a Virtek part profiler, which has proved so successful that the company is now selling time on it to competitors.

Commonalities

After visiting the three shops, certain common attributes are obvious, in no specific order. All the shops cut mostly mild steel, with stainless representing about 15%–20% of cutting output. The shops process orders from small quantities, less than 50 parts, to annual orders running into the tens of thousands. These orders emanate from customers located within a 50 mile radius of each shop, although orders from all over Britain are now more common. The shops maintain a total customer base of 2000–4000, and active customers number from 250 to 600. To prevent dependence on one customer each does not allow an individual customer to represent more than 4%–8% of sales. Generally the shops estimate cutting at about £110–£120 per hour. These shops have been in business for more than 10 years and each is prepared to expand its services to meet new customer needs. To accomplish this they have increased their sales activity and added state-of-the-art equipment to facilitate fast processing and quick order turnaround time. All run at least 24/5 on multiple laser cutters. Each shop prides itself on being customer friendly. This shows, as all the shops have been profitable. And they all average about $5 million–$6 million per year. The differences are minor. Mainly in the way orders are processed electronically and how production is controlled. Also, only one places emphasis on commercial management control software for cost tracking. Only one shop runs lights out, the other two are adamantly opposed to doing so. Even though the shops are profitable and successful, the founders and owners are deeply involved, hands-on managers. This is illustrated by the extracurricular activity they each were experiencing when I visited.

On the whole I found these shops to be representative of other UK shops. I was fortunate to take part in a job-shop seminar, where I met owners of at least 18 other shops from all over the UK. With few exceptions the observations I made at these three shops were quite similar to those I gleaned from discussions with the others. Currently the laser job shop cutting business is strong in the UK, even though increasing competition is putting the squeeze on margins, a fact of life in shops in other industrialised locales. Through their membership in the AILU, UK shops have an opportunity to discuss technology, markets, and general business activity, in an open and public forum. Germany has a similar organisation. It's too bad the USA hasn't followed suit.

Members' News

Cutting Edge is a 'World's First' Enterprise

It is not very often that anyone can claim to be the "First" or "Only" in the World but Cutting Edge Metal Processing, Inc. (CEMP), Mobile, Alabama, now has the bragging rights as the first and only company in the world with a production LASOX (LASer Assisted OXygen) cutting system.

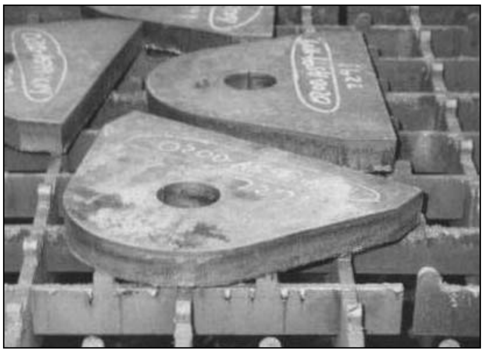
LASOX in action at CEMP

The LASOX system allows laser cutting of mild steel plate >50mm thick. After 10 months of research and development, the team of Cutting Edge/Bender Shipbuilding, Alabama Laser Systems and BOC Gases has successfully installed and tested the only production LASOX system in the world. With CEMP's existing equipment laser quality cuts have already been achieved through at least 2" steel and with further R&D the goal is 4" in steel.

CEMP is a metals processing center handling general industrial processing but specializing in shipbuilding and heavy industry applications. Located in Mobile, Alabama, USA, CEMP has the capability to blast and prime materials to 4m wide x 50mm thick and up to 15m long and forming 19mm mild steel plate up to 7.3m wide on an 1100ton CNC adaptive press brake. It has a 6kW Tanaka LMXIII (upgraded 2002) and a new 4kW Tanaka LMXV, both running on a long bed with a cutting area of 4m x 56.4m, one of the largest in the world.

In addition to being first in LASOX, the Cutting Edge lasers are the only known laser machines worldwide using wireless technology for both data input and output.

CEMP currently is running about 270,000kg of plate per week through the lasers and has recently started using a groundbreaking new resource driven planning and scheduling tool (WorkShip) developed by KBSI of College Station, Texas, USA, which should increase total throughput. Workship allows long and short range what-if scenarios which are important in a fast change environment. Workship also automates many of the administrative activities formerly accomplished manually and produces several advanced reports that are proving helpful in eliminating non-value added activities.



LASOX cut parts 75mm thick

TWI Build for the Future

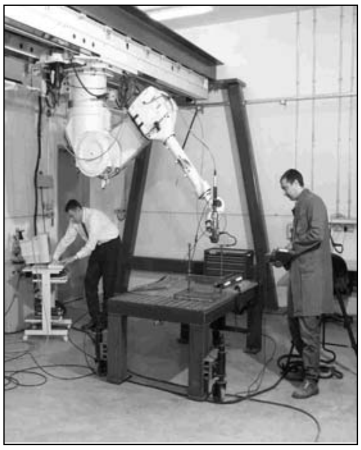
The Laser Department at TWI has recently moved into a custom made area in the new £14 million building at its headquarters in Cambridge. The new building will house the majority of TWI staff in offices, lab space and an engineering hall.

Three high power, lamp pumped, Nd:YAG lasers, with multiple fibre paths that can be beam switched between 3 cells, will carry out most of the work. Merging these three lasers using a beam combining unit can deliver over 8kW of Nd:YAG power to the workpiece. TWI is one of only a few companies world-wide that has worked with such Nd:YAG powers.

High power Nd:YAG laser units

Two additional process cells are dedicated to CO_2 laser use, for which the laser department has 8 and 3kW units.

TWI is one of the world leaders in the laser/arc hybrid welding technique and has experience in combining both Nd:YAG and CO_2 lasers with MIG or MAG to enhance the laser welding process.



Setting up for robot welding with fibre-delivered Nd:YAG

Not every laser is high power however. Within the department there is a frequency multiplied Nd:YAG, a direct diode laser capable of delivering 808 and 940nm wavelengths, a 1kW diode laser and a low power diode laser with a scanning optic, for smaller applications such as microjoining and the welding of plastics.

Recent projects include laser/arc hybrid welding of thick-section land pipeline steel, joining of large scale shipyard steel using laser alone and hybrid welding, direct laser deposition of superalloys and welding of stiffened panels for aerospace applications.

Preco acquires laser machining Inc

Preco Industries Inc., a manufacturer of diecutting, pressure forming, lamination, screen process and auxiliary equipment has acquired Laser Machining, Inc. manufacturer on August 1, 2002. Laser Machining, Inc. (LMI), now to be known as Preco Laser Systems (PLS) manufactures industrial laser systems for the metals, non-metals and converting markets. This acquisition will complement Preco Industries' development and sales of laser systems worldwide.

"We see the laser systems market as a growth opportunity. This acquisition becomes a major ingredient in our growth strategy and plans for technological expansion. We have positioned ourselves to capture new markets on a worldwide basis," said Jack Pierson, Preco Industries Chairman.

"This is a merging of two organizations that is perfectly timed for market conditions. Economies of scale, expanded product offerings, greatly enhanced market coverage, particularly in Europe all works for the advantage of our respective customers," said Pat Austin, Preco Laser Systems President and CEO.

Laser Machining, Inc. was established in 1978 in western Wisconsin and has over 950 laser systems world wide, performing welding, heat-treating, converting and other applications for the automotive, aerospace, packaging, medical, furniture and construction industries.

OpTek Systems expands its facilities

Precision machining systems manufacturer OpTek Systems is moving into new premises to allow for continued expansion of it's machine build and machining services facilities. OpTek Systems specialises in the development of laser processing solutions for a wide range of industrial applications and in transitioning these processes into reliable production line solutions.

OpTek machines have been widely adopted across a range of industries, machining optical fibre for telecommunications, medical and scientific applications; drilling holes in domestic and medical aerosols and injectors; cutting, scribing and perforating packaging materials; and a host of other manufacturing requirements.

OpTek Systems will open its new 7,000 sq ft headquarters on Abingdon Business Park on the 1st of January 2003.

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Welcome to New Corporate Members
(since September 2002)

Acorn Laser Ltd

Aerotech Ltd

Alcatel Optronics UK Ltd

Armstrong Precision Service

Burrhart Machinery Ltd

Cradhill Industries Ltd

Dragon Laser

Fimark Ltd

Gemflex Engineering Ltd

Laser Experience

Lasers Are Us

Malton Laser Limited

Metal Craft Industries UK Ltd

Metals UK Ltd

Precision Profiles

Premier Laser Cutting Ltd

Products of Technology

Steel Service Centre Ltd

Wrexham General Engineering Ltd

Hydram Celebrates 25 Years

Hydram Engineering Limited, established in 1977 as a small family-run firm, was one of the first businesses to occupy a nursery unit on the then-new industrial estate at Chilton, County Durham. Since then it has gone from strength to strength, now occupying a site of over 50,000sq ft and employing 80 people. This year, Hydram is celebrating 25 years of providing subcontract sheet metalwork services to businesses mainly in the North East.

Judith Porter, co-founder and Financial Director, says, "When we set up the company, we always considered investment in the latest machinery and technology to be a priority. This policy has not changed and this year, in addition to the 4kW Bystar that was commissioned in January, we have recently purchased a new 280-tonne 4m press brake.

Trumpf Ltd Double Victory

Two Trumpf companies, Trumpf Lasertechnik and Trumpf Werkzeugmaschinen – both in Ditzingen Germany, have been named Factory of the Year for 2002 in the prestigious competition organised by the German weekly magazine, 'Produktion' and management consultants A. T. Kearney Inc.

What most impressed the jurors was how Trumpf successfully divided up the complexity of production in easily controllable decentralised units. Commenting on the double victory, Trumpf's Executive Vice President Dr. Mathias Kammüller, said "We are probably the only machine tool manufacturer that organises the production of all its machines and sub-assemblies in continuous flow assembly. The award honours this achievement."

Camtek expands US business

Camtek has expanded its US business operations through JET-CAM-Camtek Americas, Inc. The move allows the complete range of group products from JETCAM and Camtek to be supplied through a single source.

"It makes good business to combine our sales and technical resources throughout the American continent. Customers have access to a much larger technical resource, which also allows us to quickly tailor a wider range of products to users precise needs. More resources are also now available for our OEM partners," said Brian Warner, MD of Camtek's UK headquarters

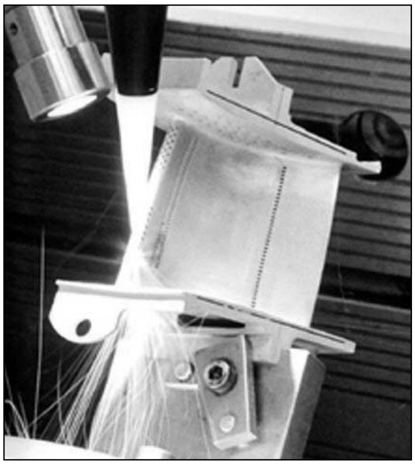
MJT presents new product range at its 3-day Open House

The MJ Technologies Open House Event in November presented the new MJT developments and offered process demonstrations of EDM, LASER and ECM systems to customers on a more focused level than was possible at MACH earlier in the year. The event, which ran for 3 days, was well attended by many customers from overseas including Italy, Netherlands, Germany, France and Switzerland.

The new developments included the FHD Series of EDM Machines for fast hole drilling, the LMC Series laser products for cutting, welding, drilling and ablation and the self-contained STEM TECH drilling systems for high depth-to-diameter ratio holes.

Neil Main from Micrometric Techniques gave an invited talk on the MJT Alpha CO_2 Laser machine for fast, accurate profiling for Automotive & Aerospace.

Feedback from visitors after the Open House has been extremely encouraging. "I was impressed with the sense of team spirit that you all seem to have and all appeared to be happy in your work – it was a rare occasion to be able to meet and chat about improvements to existing processes and hear about new techniques still in their infancy," said one UK-based visitor.



Hole drilling at MJT

New President for UKCPO

At the EGM of the UKCPO held on 20th November, Professor Julian Jones (Heriot-Watt University) was unanimously elected as the next President of the UKCPO, and Professor Allan Boardman (Salford University) was unanimously elected as Vice-President. They will take office as from 1st January 2003.

"I want to thank the UKCPO Committee Memmbers for the help and support they have given me during my term of office, especially in regard to hammering out a workable constitution for the UKCPO, the organisation of three overseas missions, and initiating the Photon CSX series of conferences," said retiring President Colin Webb.

"I am sure that you will be equally supportive of Julian and Allan in their work and will join me in wishing them every success in growing the UKCPO as the leading organisation representing all aspects of the UK's community in Optics and Photonics," he added.

Electrox 'Productivity Partnership'

Productivity Partnerships 2002, an annual metalworking exhibition staged at the 600 Centre, Shepshed, near Loughborough, took place from 15th – 17th October 2002.

The Electrox 'Lazerblade Plus' sheet metal profiling machine was on display at the exhibition. Lazerblade Plus comes with a range of bonus features, including Precitec cutting head, the GE Fanuc 180i MB PC CNC with touch sensitive colour screen and full QWERTY keyboard for simpler and faster operation, automated in-process recovery, program re-trace, automatic edge finding with re-orientation of work co-ordinates and LAN connection for interfacing with factory systems.

There are three models in the range – 1500, 2500 and 3000 Watts - offering what is claimed to be the best value-for-money sheet-metal profiling machine on the market

Electrox Lazerblade Plus sheet metal profiling machine

Bolton TIC

Bolton TIC, opening September 2003

Bolton Technical Innovation Centre has been established to nurture innovation and a spirit of enterprise in young people.

The TIC is driven by industry need. It will equip young people with a blend of scientific, technological, business and interpersonal skills in a way not provided by any other programme for students of their age. Capable and motivated students aged 14 to19 who want to develop their skills further will be helped to realise their potential as the high performing technologists, project managers and entrepreneurs of the future, through their own efforts, in a mix of project work and tailor-made learning units.

The TIC is a specialist resource, housed in a unique purpose-designed new building. Equipped with the finest design and manufacturing facilities, with full-time staff and part-time mentors seconded from industry, open during and after the school day, at weekends and throughout holidays, and free from the constraints of the National Curriculum, the TIC promises to be a wonderful asset.

The TIC is being hailed as a breakthrough in arresting the decline in numbers of science and technology graduates, and a wonderful opportunity for young people and a source of lasting benefit to industry. But this is a symbiotic relationship. As the TIC meets the needs of the regional industrial community, a high level of support from seconded tutors from local business is needed, sponsors and volunteers.

The value to the community is recognised by the significant level of support being received from the Northwest Development Agency. The Bolton TIC will in turn serve as a regional and national model, and other TICs are already being considered. As the national pilot, Bolton TIC looks to establish relationships with organisations of the highest reputation, a shared interest in finding innovative and enterprising people, and a desire to make an impact, or just to make a lasting difference.

For further information, contact paul.abbott@uktic.org

AILU's Young Laser Engineers

Back in Issue 10 (Feb 1998) we highlighted the actiities of some of the young UK laser researches. Now, 4 years later, we decided to find out where their careers had taken them

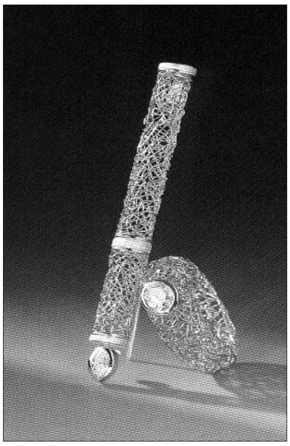
Anne-Marie Carie

Anne-Marie works for the Jewellery Industry Innovation Centre (JIIC), which is affiliated to the School of jewellery situated in the centre of Birmingham's historic Jewellery Quarter.

Ann-Marie Carey

The JIIC was established to assist companies within the jewellery industry, its remit to provide support in research, development and new technology applications. Anne-Marie's role within the centre is to help local industry develop products incorporating the Centre's laser technology.

"Coming from a jewellery background and having studied in the Laser Group at Liverpool I am in a position where this combined knowledge is utilised. Currently we have two laser spot welders and one laser marker available for the development of jewellery products," said Anne-Marie. "Over the last few years lasers have begun to make a real impact in the jewellery trade in particular laser welders, which have become an increasingly flexible tool for the jeweller. Laser Spot Welders provide an accuracy and localisation of the welding process that allows designers to think beyond their normal constraints, developing innovative jewellery where both design and process have pushed the boundaries. For instance welding can take place against heat sensitive stones, multiple welds can be performed in close proximity to each other and very delicate components can be welded together easily. The most interesting and innovative work comes where creativity is combined with the specific advantages of the system to produce pieces that would not have been possible before," she added.



Broach and ring by Tom Rucker, a Goldsmith specializing in laser welding. They are fabricated in 0.4 mm round Platinum and 0.8 mm 18ct Yellow Gold wire. Both are hollow forms with multiple welds in close proximity.
Platinum is an idea metal for this type of work as there is minimal dispersal of heat which, combined with the consistency of welding across the piece, providing a remarkable strong construction.

Emma Johnston

Emma is AILU's 2002 Young Laser Engineer, for her work on Laser Scabbling at the University of Liverpool.

Emma Johnston

Emma now works as a research scientist at BNFL Sellafield, who see the process as a potential decommissioning tool for the nuclear industry. "Using scanning mirrors permits complete remote operation and eliminates the need for heavy end effectors or complicated robotic systems," said Emma.

Aileen Kearns

Since September 2000 Aileen has worked in the Optical Components Industry as a Product Engineer in NPI (New Product Introduction). For the majority of this time, she was employed by Nortel Networks Optical Components in Paignton, Devon until the acquisition of the transmitter and receiver business by Bookham Technology on 8 November 2002.

Aileen Kearns

"The growth of the internet and wireless communications has driven the demand for system bandwidth. In optical networking much of this has been met by DWDM (Dense Wavelength Division Multiplexing) technology, which allows more channels to be sent down existing fibre at different wavelengths. The current fibre backbone rate per channel in long haul communications is 10 Gbps (OC192). This is equivalent to transmitting about 15 CDs of information per second," said Aileen.

"I work in the Mach-Zehnder Transmitter NPI team where we develop and introduce to manufacturing new high-speed transmitters based on both InP and GaAs technologies for OC48 (2.5 Gbps), OC192 (10 Gbps) and future higher lines rates such as OC768 (40 Gbps)," she said. "Though a small amount of industrial laser material processing activity exists within the business I am no longer involved in high power laser applications. In telecom applications 100 mW is regarded as a high power laser and when we talk about 'laser processing' in Bookham we are referring to the processing of semiconductor lasers in our chip fab facilities."

Aileen's outlook is positive. "The Telecoms Industry has taken a bit of a battering in the last 2 years with headline-grabbing redundancies and high profile carrier bankruptcies. Nevertheless, the demand for bandwidth has to continue upwards so the fundamentals of the optical components business remain strong and a recovery is just a matter of time."

Nick Longfield

Nick Longfield graduated from Coventry University in 2001 with a PhD in 'ultrasonically modified laser welding'. The augmented welding process enabled deeper weld penetration for a given laser power and welding speed. The ultrasonic energy imparted to the weld pool also aided in decreasing porosity levels and refining the dendritic structure of mild and stainless steel.

Nick Longfield

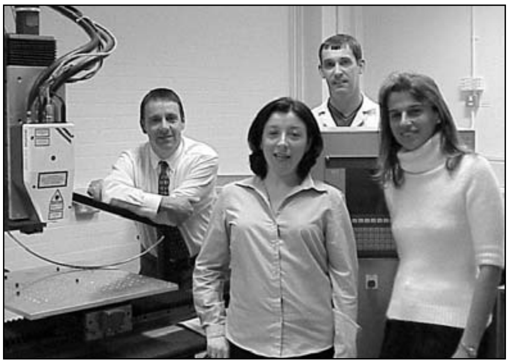
"After graduating, I worked as a teaching company associate for Coventry University until taking up my current position with Corus UK in Rotherham as a welding research and development engineer," said Nick. "My current role at Corus involves UK automotive customer support, laser welding research, development and safety," he added.

continued opposite

Nottinghams new laser group

The School of Mechanical, Materials, Manufacturing Engineering and Management is home to an active new laser group.

Current projects include a PhD related to laser drilling of aerospace components for Rolls Royce using a JK704 YAG laser (Claire McNally), various projects in diode applications, such as, welding of aerospace materials, cladding and rapid prototyping (2 PhD students) using the groups new 2.5 kW Rofin Sinar Diode laser. Other projects include blades repair, heat treatment, cladding collaboration with Lulea University and various student projects with CO_2 lasers.



Professor Ian Pashby, Claire McNally, Stuart Branston and Janet Folkes. Members of Nottingham University School of Mechanical, Materials, Manufacturing Engineering and Management. Working with lasers for drilling, heat treatment welding and cladding / rapid prototyping.

Laser Experience

Laser Experience is an industrial laser applications and training consultancy, founded my Peter Thompson in 1989, and based in Rugby. Before starting out as an independent consultant Peter spent 10 years working in laser applications at Lumonics in Rugby.

Peter Thompson

Laser Experience provides support to businesses who currently use, or wouldlike to use, lasers in their manufacturing processes.

"For manufacturers who have not used lasers before, knowing what lasers can do and what they can't do can be a problem," said Peter. "We provide unbiased advise on the choice of laser equipment. We can then go on to develop the necessary processes to production standards. Similarly, for companies who already use laser equipmentwe, we assist them to develop new products and/or processes as their markets change."

Laser Experience also provides a comprehensive range of training activities for designer engineers, process engineers, operators and any other persons involved in the specification and realisation of laser-processed products.

Young Laser Engineers (continued)

Jonny Magee

Since completing his PhD work at the British Aerospace corporate research headquarters, Sowerby, in Bristol, in the autumn of 1998, Jonny moved back to The University of Liverpool and started lecturing in the mechanical engineering department, with his research interests still based in the laser lab. In September 2000 he left Liverpool and returned to Galway on the west coast of Ireland to take up a senior R+D scientist job in the National Centre for Laser Applications in the National University of Ireland.

Jonny Magee

"On moving to Galway I built an ultrafast laser-micromachining workstation and I have since been involved in developing industrial drilling and micro-machining applications on metals and semi-conductors for industry with the femtosecond laser. I have also been applying other more conventional pulsed Nd:YAG laser sources for welding cobalt alloys and cladding heavy metals for industrial clients," said Jonny. "The work requires a lot of technical input, both on a practical level and for preparing proposals and reports. I need to be up to speed with a lot of technology from the intellectual property and patent perspectives as well as the academic literature. A good proportion of my time is spent meeting clients and carrying work out on site as well. The NCLA has a lot of experience in technology development and transfer and operates quite differently to an academic research laboratory, as deadlines are generally much tighter."

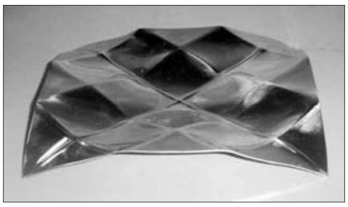
"I have stayed with laser technology throughout the last 7 years and it has been an interesting journey so far, I have been fortunate to get a lot of exposure to different technologies, institutes, companies, situations, personalities and places to live throughout!"

Sarah Silve

At the time of the original article, Sarah had spent about a year researching laser forming for use in small scale decorative objects and tableware; a project that produced a range of complex surfaces, objects and vessels. Whilst taking time out to write her thesis she also studied for a certificate in teaching to gain a better understanding of learning styles and communication techniques.

Sarah Silve

"In the summer of 2001 I joined the Department of Mechanical Engineering at Brunel University with a view to starting a new laser forming project," said Sarah. "The last 18 months have been spent setting up a CO_2 laser facility and developing a programme of work. Along with continued research into developing three dimensional parts, the project aims to raise awareness of the process and extend the use of the facility to others, so as to increase the use of laser forming in applied arts and associated manufacturing industry."



An example of a laser formed part

"This is likely to be an exciting period of activity and I am looking forward to working on live enquiries as well as gaining experience of other areas of laser material processing and research methods," said Sarah.

Karen Williams

Karen is a lecturer in the Department of Mechanical Engineering at Loughborough Universirty. She is currently on maternity leave and is due to return to the university in May 2003.

Lambda's 25 years of service to the UK laser community

"I find it hard to believe that I have spent almost 40 years talking to people about lasers, demonstrating them and explaining that they are not the weapons of destruction beloved of Star Wars aficionados," said Lamda's founder Bob Carless. "I have enjoyed watching them develop from being a curiosity or solution looking for a problem to their current status of being a taken-for-granted component of a CD player, telephone system, medical instrument or material processing machine. But there it is, five years of working for the UK distributor of Spectra Physics, almost ten years of running Spectra's UK subsidiary and, in 1977, setting up Lambda Photometirics to market and maintain lasers, optics and electro-optic products in the UK,"he added.

"Looking back on the 25 years since then it is reassuring to see that Lambda still represents some of the five companies we began with – Zygo, Quantel, Electrophysics and from soon after our start up Physik Instrumente, Polytec, Inrad and OFR. What is perhaps more telling is that we still supply product to many of the same customers we had in those early days. It is also good to report that we also have people at Lambda who have been with us 15, 17 and some more than 20 years contributing significantly to our success. We must be doing something right!" Bob said.

Adrian Harrison and Bob Carless

In 1993 Lamba joined forces with the German firm Polytec and is company is now a wholly owned subsidiary of Polytec-PI but essentially operating independently in the UK with Adrian Harrison, a twenty-two year Lambda veteran, now running the company.

Steel Service Centre buys first Bytube in UK

Pullmax Limited has received an order for equipment valued at in excess of £500,000 for the UK's first Bystronic Bytube laser from leading sub-contractor Steel Service Centre. The Bytube 3204 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. It is also equipped with the powerful 3000 kW resonator.

Steel Service Centre provides an all round laser cutting sub-contract facility to a wide range of OEM's and fabricators. The company is an existing Pullmax Bystronic user having commissioned a Bystronic Bysprint in August 2000 and a Bystronic Bystar in 2001. The Bytube represents a new venture for Steel Service Centre and emphasises the company's core confidence in laser cutting.

Austin Jarrett, the company's managing director comments: "Whilst our turnover is standing at around £1.5M, we were looking to expand the business and accepted that the way to do this was to embrace laser technology, both flat bed and tube, even further. "

"Investing in laser tube technology is a strategic business decision as opposed to our satisfying demands from our customers. We looked at other countries, in particular Australia, Germany, France and Italy. These countries have all embraced flat-bed laser technology wholeheartedly in the past and have now moved onto laser tube cutting. As with flat bed laser technology we saw that the UK is slow on picking up on the advantages of laser tube cutting and we therefore saw an opportunity for Steel Service Centre to break into this market.

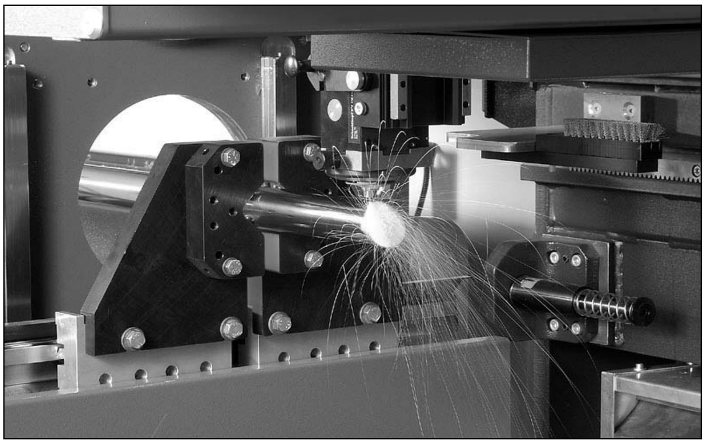
"Designers and engineers in these overseas markets have changed the design of their products/components to incorporate the high accuracy and efficiency of tube cutting. As a company we are confident we can encourage the same thing. We want to be a position where we can supply customers with flat plate profiles and box and round sections on the same pallet; this concept can be compared to FMS production."

Steel Service Centre took nine months to investigate the machines available to the UK market looking at every aspect of the machines, running time studies and time trials on complex components. No budget was set, the company just wanted the most appropriate machine capable of handling the largest range of box and round sections.

"All the machines were similar, all the companies involved were professional. However, our decision ultimately came down to service. We have always enjoyed fantastic service and back-up from Pullmax and we know this is an important factor when investing in such highly technologically advanced equipment."

Steel Service Centre expects that the Bytube will enable it to find more appropriate design solutions for existing companies and allow them to handle more work from these companies, as well as open up new markets.

"Currently most of our clients are local. However, as a company offering a specialised service we anticipate we will be able to expand into other parts of the UK and anticipate that our turnover will rise from the current £1.5M to £3M by the end of 2003."



Bystronic Bytbe 3204 in action

Rofin Baasel's new laser welding unit for the tool and mould industry

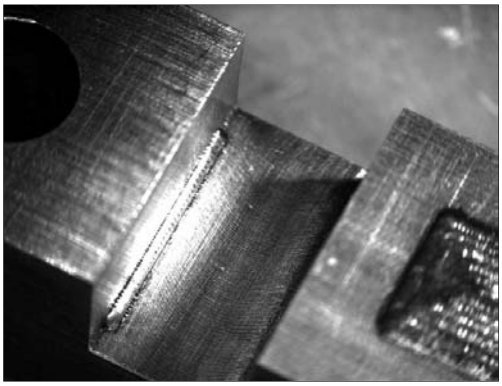
The new open laser welding system StarWeld Tool Open by Rofin Baasel Lasertech completes the family of laser welding systems for the tool and mould-making industry. With this tool repair system, the laser is brought to the workpiece, allieviating the need for elaborate disassembly of large-scale tools. The open version of the StarWeld Tool family is of modular design for ease of adaptation to individual requirements.

Baasel Lasertech offers a basic version, the StarWeld Tool Open Basic, equipped with a StarWeld 40 or 90 laser, a 400 µm fibre, a Vario Compact welding head, a LCD monitor, a controller unit via joystick and a three axis motion system (two motor-driven and one manual).

Customers can vary and expand the individual basic package. For example the StarWeldTool Open Bench comprises a workbench, optional fixed manual axes and a x-y stage. The StarWeld Tool Open Gantry is a portal system for positioning the laser across the welding spot. Alternatively, customers can fix the laser head and the laser drive to their existing machine tool (e.g. milling or eroding machine) and use it as the positioning system.

The StarWeld Tool Flexible includes motor-driven axes that are fixed to the workpiece. The laser beam is fibre-delivered and the optics are positioned roughly above the damaged region. The optics can then be swiveled ± 60° via a ball joint in the x and y axis andcan rotate the fibre by 360 ° around its own axis. The user then moves the laser to the exact area to be repaired or welded using the xy stages and either a micro camera or directly via a stereo microscope. A joystick control unit allows set up of all axes and laser parameters with one hand.

StarWeld Tool Open is a modular, open welding system designed for individual user requirements



Laser deposit welding with filler wire. A 200 µm wire can achieve a 400 µm weld that requires hardly any finishing. Repair costs become negligible.

All laser sources are mobile, as well as the workbench of the StarWeld Tool Open Bench and the StarWeld Tool Open Gantry, and can be moved comfortable from hall to hall and from one works to another. After connection to the power and shielding gas supply the laser is ready to use.

The complete family of welding lasers for the tool and mold making industry comprises the small manual StarWeld Tool Performance (loadable up to 6 kg max.), the larger brother StarWeld Tool Integral (up to 350 kg) and the open StarWeld Tool Open (up to 20 t and more) with its four different systems versions. With this family Rofin / Baasel Lasertech covers the entire range of applications in the laser deposit welding with filler wire in the tool and mold making industry.

Innovative extraction arms online

Purex International are now offering their dust and fume extraction arms as a new product range that is available from their website at *www.purexltd.co.uk*.

A large variety of arms, nozzles, cowls and connections are available depending on the applications, including laser processing, laboratory/cleanroom work, medical procedures, soldering, welding and glue/solvent use.

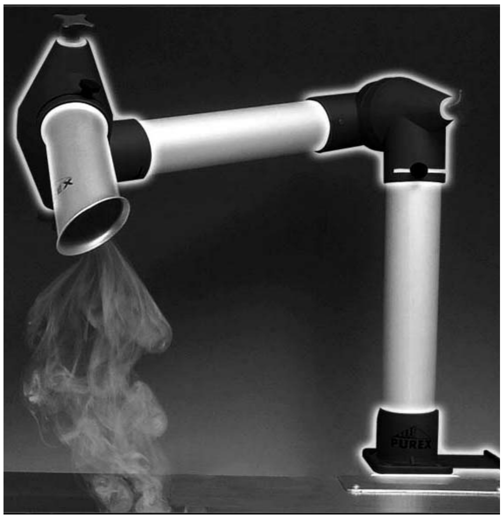
The website shows full technical details and prices, the range includes 25, 38 and 100mm Flexible Arms, Plenum extraction chambers and Cleancabs but of particular interest are the 54mm Multi-Position Arms, which feature a patented joint design to ensure reliable positioning, time after time.

The joint has been designed to overcome an inherent problem with other Multi-Position Arms, that over time joints lose the tension between their halves causing the arm to slip. Consequently the extraction nozzle could: -

- Drop into the path of oncoming product if used, for example, on a laser marking line.
- Knock over bottles of chemicals in a laboratory.
- Damage the product being worked on, for example a PCB in a soldering application.
- Be dangerous if used in a medical procedure.

A spring loaded tensioning bolt enables the operator to tighten the Purex 54mm arm using minimum force, creating a positive lock between serrated inner cams on the inside of the joint. Once set to the correct tension, the position of the arm can be adjusted without unscrewing and re-tightening the bolt. The spring action allows the cams to ride over each other and click back into place as the arm is rotated, relocking the new position automatically.

Most of the arms can be used with an existing extraction system by using a suitable conversion kit or alternatively extraction and purification units are available from the Purex range. For further information visit the Purex web site.



The Purex multi-position extraction arm

Laser Resale launch Water Jet Technology

Laser Resale has set up a new company, WaterJet Technology, offering water jet machine services. As a first step they have installed the latest Bystronic Byjet water jet cutting system in their new purpose built Astoria Court facility.

With the accuracy and reliability of the Byjet machine allied to the experience of the operating personnel, WaterJet Technology are offering a competent and quality-conscious cutting service to industries such as Aerospace, Architectural, Construction, Electronics, Mechanical Engineering and Fabrication, Medical, Technology and Packaging.

<u>Benefits of this service include:</u>

- Virtually burr-free cut edges without heat generated structural changes.
- Close nesting of shapes giving economical conversion of high value materials.
- Multi-head operation allowing competitive cutting of flat materials, 3m x 1.5m capacity, from shim material to 200mm thickness.
- Rotary axis for cutting of apertures and profiles in tubular material, up to 2.7m long and 500mm dia.
- Over 20 years combined knowledge of programming and operation of WaterJet profile cutting machines to meet customers' cut component requirements.

A wide range of materials can be cut by water jet:

<u>Metals:</u>
Aluminium, Brass, Bronze, Carbon Steel, Copper, Stainless Steel, Nickel Alloys, Titanium.

<u>Non Metals</u>
Carbon Fibre, Ceramics, Granite, Glass, Laminates, Marble, Glass, Reinforced Plastics, Plastics.

<u>Soft materials</u>
Foamed Rubber and Plastics, Elastomers, Rubber and Rubber bonded materials, Synthetic Fibre materials.

Mobile Laser Welding Workstation

ALM-150 for mould tool repair

Laser Lines (Industrial & Medical) Ltd have introduced a NEW mobile laser welding workstations for mould tool repair and modification. Being mobile does not imply any compromise on power: the ALM-150 is based around the new 150 W laser from Alpha Laser.

The ALM-150 if fully self-contained and built on to a rugged chassis for on-site work as well as the repair and modification of large tools that will not fit into a conventional workstation.

In line with rest of the Alpha Laser range, theALM-150 has been ergonomically designed to maximise operator comfort and ease of use. All main operating functions can be set from arm just behind the laser head, or by the unique multi-function foot switch.

The alpha Laser 150 W range also includes the AL-150, an OEM package ideal for mounting in existing workstations or into custom enclosures and process machinery.

ALW-150 is a self contained fully enclosed workstation for the repair and modification of mould tools up to 350Kg in weight. The ALW-150 can also be used for general high precision and micro welding work on a wide variety of metals including precious metals.

New Pyroelectric Heads from Ophir

BFi OPTiLAS Limited have announced that Ophir Optronics has revised its entire line of Pyroelectric measuring heads. The Pyroelectric Heads combine high accuracy, high damage threshold and high repetition rate operation in a single head.

Previously the PE Series Pyroelectric heads could measure long pulse up to 3ms and a repetition rate of 5kHz. The new V Series now include the new damage threshold heads for excimer lasers. The new features include repetition rate of 400 Hz, pulse width to 10 ms, linearity ± 1% and UV damage to 1 J/cm^2.

Parker Steel offers on-line ordering

Steel can now be purchased on-line as easily as buying a book on the new website developed by steel stockholder, John Parker & Son Limited of Canterbury.

By logging on to <u>*www.parkersteel..co.uk*</u>, claimed to be the UK's first steel stockholding e-commerce website, businesses can view, select and buy steel on-line, 24 hours a day, 365 days a year. The buying process is completed within ten 'clicks' from start to finish and purchasers can pay on-line via credit card or on account if they are existing customers. Buyers can order standard stock, from a single bar measuring 3m x 3mm up to several tonnes of steel, and providing the order is placed before 6pm, Parkers guarantee next day delivery anywhere in the South of England, East Midlands and East Anglia.

Parkers has developed the e-commerce site to meet the needs of small and medium-sized businesses who purchase small quantities of steel on an infrequent basis. The site will also prove useful for estimators who require instant access to information on steel prices.

New Industrial Grade Diode-Pumped YAG Laser Modules for Laser Marking

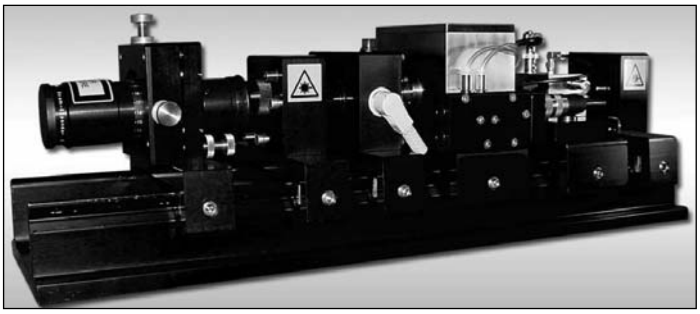
Laser SOS has introduced a unique line of industrial grade diode-pumped YAG laser modules for OEM integration.

There are three standard modules producing 10W to 75W of CW power at 1064 nm wavelength. A unique side-pumped-diode architecture provides superior beam brightness and beam pointing stability.

"These diode-pumped modules have been designed and engineered to provide a highest degree of diode protection than is available in other competitive products," said MD Tony Koszykowski. "These unique diode modules have been designed with in-head sensors that continually monitor coolant flow, coolant conductivity, humidity and voltage spikes," he added.

As a further precaution a unique internal environmental gas purge facility provides the diode-module with additional long term protection. In the event of any one of these conditions failing, the diode module is programmed to automatically shut down, minimising any potential damage to the diode.

The diode modules come with a warranty of 5000 to 8000 hours subject to agreed terms and conditions. The diode modules have been ergonomically designed with a minimal component count



The Laser SOS industrial-grade diode-pumped Nd:YAG laser

for ease of assembly and ultimately resulting in a lower manufacturing cost

All diode-modules utilise built-in Q-switch coolant ports, push-fit coolant connectors and rapid swap-out process cabling that allows for quick, simple and efficient integration.

A complete line of dedicated diode-pumped laser components are also available, all components and devices are compatible and have been fully approved for OEM integration. In addition fully configured laser resonators are available as standard OEM products.

Manufacturing Advisory Service

The Manufacturing Advisory Service (MAS) announced in February 2001 is now being developed by DTI in partnership with Regional Development Agencies (RDAs) in England and the Welsh Development Agency for Wales with certain networking aspects extending to Scotland and N.Ireland as well. The MAS is being planned as an integrated service for all UK Manufacturers, although MAS Advisers to be specifically employed to deliver 'hands-on' practical help will focus on the needs of smaller firms.

The service will be delivered through three main components:

• Regional Centres for Manufacturing Excellence (RCMEs).

• A Network of Centres of Expertise in Manufacturing (CEMs).

• The MAS website which will link manufacturers to RCMEs.

We have already put in place the National Network Development team under INBIS Plc and the first RCMEs are now being appointed (for further explanatory information on this visit our site http://www.dti.gov.uk/manufacturing).

The National CEM Network will have a membership base drawn from the wide range of organisations that could be of benefit to businesses involved in manufacturing. This will include centres of expertise in manufacturing technologies, skills and training, industry sector bodies, centres of knowledge and research. Organisations accepted as CEM) will be included on a national database, freely accessible to through the MAS website. Anyone interest in becoming a CEM should complete a Register of Interest form available from Tony Boylan at tboylan@inbis.com.

There are significant benefits for CEMs who become national network members. The MAS website will be a credible globally accessible marketing tool for those CEMs included on it. Manufacturers, SMEs and other bodies using the MAS and the website will be directed towards the CEMs with the most relevant expertise and services and CEMs will engage with users on their own mutually agreed terms and conditions.

LASAG's new 500 W Welding Laser

LASAG has introduced a new addition of the very successful field-proven FLS laser series.

The FLS 542C, a pulsed Nd:YAG laser system, was introduced at the IMTS Show, Chicago (USA), September 2002.

The Real Time Power Supply, unique to the FLS 542C, makes this laser even more attractive for peak power controlled, highly reproducible Spot and Seam Welding applications of metals and other materials where demands on production throughput quality and repeatability are high. As such, the new laser will be targetting primarily at the Automotive, Electronics, Medical Device, Aerospace and similar industries.

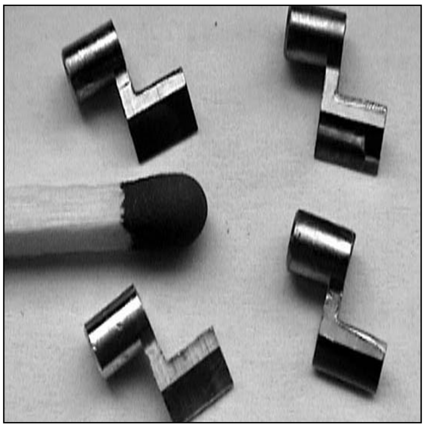
The FLS 542C laser system covers a working range of up to 500 W. The laser unit is compact in design requiring little floor space, yet the design is service and user friendly. It can be integrated easily into new or existing workstations.

The new laser is available with up to 6 fiber outputs for energy and/or time-sharing with pulse forming and pulse on demand capabilities. Other features are the completely sealed power supply with active water cooling, multiple interfaces for easy integration and modem for remote operation and diagnostics.

The new FLS 542C laser for precision welding

LBP's new small laser mirrors for high power laser beams

Laser Beam Products (Biggleswade) have developed a range of extremely small laser mirrors for high power laser use.



"For scanning applications, aluminium mirrors just 2mm square have been made, complete with coupling for a shaft. They weigh just 200 milligrams," said MD Mark Wilkinson.

"For medical applications several hundred copper mirrors just 5mm diameter 1mm thick have been supplied for use with a dental laser handpiece. These weighed in at a fairly heavy 2 grams!"

Due to the high damage threshold of metal mirrors it is possible to use these miniature mirrors after a lens in the partly focused beam where the energy density can be very high.

"At the other end of the scale, our largest laser mirror 150mm diameter and 25mm thick weighed in at 4 Kg and took all day to cool down after coating," commented Mark.

Electrox teams with software company to develop medical marking product

One of the main challenges facing any NHS Trust today is the need to monitor and control the vast range of instruments currently used in modern surgical procedures. And as sterilisation of instruments is currently managed on a batch basis there is no means of identifying and tracing an individual item as it is used, sterilised and stored within the Trust. As newer, more complex surgical interventions are developed and the diversity of instruments increases there is an urgent need for an automated means of identifying and tracing individual instruments as they move through the system.

Now a computerised system developed by Peterborough-based Servo Software Systems in conjunction with laser systems specialists Electrox provides the solution.

The combination of Servo's software expertise and laser marking technology from Electrox allows specific instruments to be traced throughout the cleansing system. Most importantly the new system identifies instruments as they both enter and leave an operating theatre, provide a precise count of the instruments used and detect any possible loss of an instrument - either in the theatre or in the patient - during the operation.

The new system employs an Electrox marking laser to put an indelible mark directly onto the surface of each instrument in the form of a Data Matrix code (a high capacity, two dimensional symbology), which is read by a hand-held scanner to access and maintain the historical information related to that instrument held on a central database supplied by Servo. The laser marked Data Matrix code is permanent and resilient to innumerable passes through the hospital's cleansing unit and the Servo database can be used to audit instrument usage and life.

A week long trial carried out recently at Pontefract Hospital in West Yorkshire showed that each instrument can be successfully marked in under three seconds and any items too small to be marked directly or that are manufactured from an incompatible substrate, can be permanently marked on a tag attached to the instrument.

Within the context of the current cleansing regime each surgical unit tends to have its own sterilisation facility on site but with this kind of enhanced tracking system, Trusts can now contemplate sharing sterilising capacity between several sites and benefit from the economies of scale that a centralised resource could bring.

As well as the obvious benefit of tracing specific instruments to procedures carried out on individual patients, the new system has the ability to monitor the value of the stock of instruments owned by a Trust.

Permanent identification of instruments also enables a Trust to determine whether an item sent for repair under warranty outside the hospital is returned or replaced.

Pontefract Hospital is the first hospital Trust in the country to investigate this application and Angela Fairbank, Sterile Services Manager at Pontefract said, "We are greatly encouraged by the trials of the system. The permanent quality of the marking met our expectations and the information available via the instrument database offers real advances in patient care and safety".

Servo Software (formerly Healthcare Computer Systems) is the market leader in the UK for computerised traceability systems for hospital sterile service departments, with over 160 systems throughout the UK. Over 15 years experience in the provision of product traceability systems in this market means that Servo's considerable expertise in this field is second to none.

Electrox is the UK's largest integrated manufacturer of industrial laser systems for marking, cutting and welding. Formed in 1979 and now a member of the 600 Group plc, Electrox has a wealth of experience of materials processing with lasers. Electrox supplies and supports customers in a diverse range of industries throughout the world.

Raylase Optical Power Stabilisation Control for CO_2 Lasers

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One of the single largest problem areas affecting the use of Carbon Dioxide lasers on fine processing jobs is their inherent power output instability. The instability may be caused by a multitude of factors, one of which may be the variation in cooling water temperatures and the expansion and contraction of the laser cavity length.

Most CW CO_2 laser manufacturers will specify their products to be stable within ±7%, after a 'warm-up' period. Depending on the type and construction of the laser cavity, a multitude of 'Axial Mode Pops' or sudden jumps between output transmission phases may occur during this warm-up period. such features are illustrated in figure 1, which shows the power output of a Synrad 48-2 25W laser, and clearly demonstrates large instabilities in laser power output when switching a laser on from cold and driving it with a constant input modulation at 5kHz 50% duty cycle. Note the mode pops within the first 12 minutes of operation, pushing the laser power output stability up to ±6.2% in this case. Cooling water was maintained at 20.1 ±0.2°C at 10 readings per second.

Certain process applications require a far finer level of power stability, and here at Raylase we have been developing modulation driving and optical filtering techniques in order to improve power stability when CO_2 lasers are used with our scanning products.

To date, the modulation driving technique has given no better than ±1.1% stability after a warm-up period, and has been employed with our PCD (Power Control Device) technology to govern laser power density reaching the target in direct combination with scanning speeds.

In figure 2, the upper line is the laser output (same laser and operating conditions as for figure 1) monitored before the optical filtering loop and the lower line is the output post optical filtering. The optical filtering using a modified version of the PCD has proved to be far more effective and to date we have achieved power stability control to ±0.112% after a 15 minute warm-up where instability was still controlled to within ±1.31%. The OEM power monitor head has a drift error of less than ±0.003%.

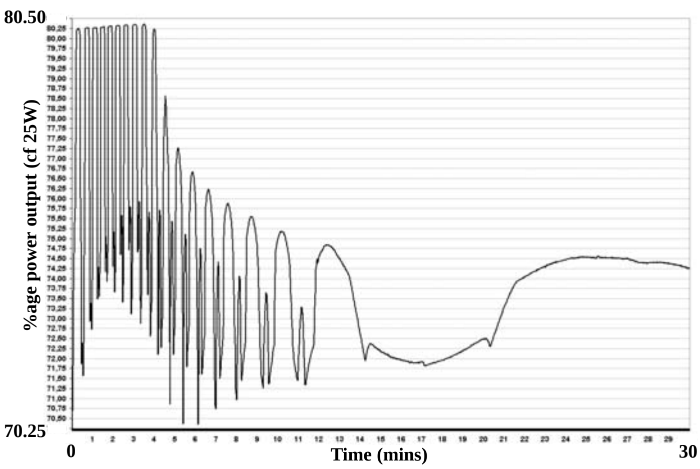


Fig. 1. Output power from a Synrad 48-2 during warm-up, without control

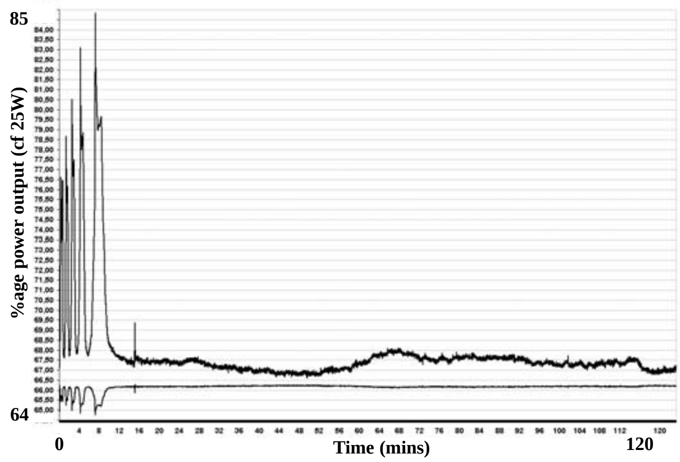


Fig. 2. Output power from a Synrad 48-2 during warm-up, with Raylase AG Optical Power Control.
The upper line is the laser output monitored before the optical flitering loop, the lower line is post optical filtering.

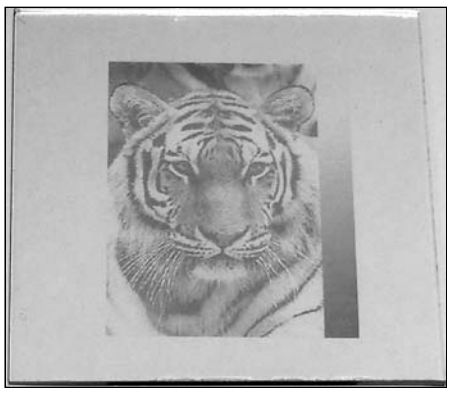
Raylase AG have taken the first order for an optical filter controller to be employed in the field of security glass marking. Here the laser is given a constant input modulation and the optical filter control is undertaken by a modified PCD or Power Stability Controller.

The Power Stability Controller is operated via the same Raylase Laser Stabilisation software that can be used for input modulation driving, a SP-ICE PCI controller card and an Analog-to-Digital signal convertor card. A second SP-ICE controller card provides constant modulation to the laser source and also governs all scan head actions via laser marking software.

The Controller comprises one galvo driven control optic, one static beam forcing optic, a partial reflector and a CO_2 power measurement head. Downstream of the Controller is the safety shutter, followed by an Acousto-Optical Modulator which takes over the control of laser modulation to the target via a Raylase Razorscan-15 scan head.

Figure 3 below shows a 175dpi bitmap image which has been scanned onto a doped piece of glass using optical power stability control. and clearly illustrates the superb performance that can be achieved.

Fig. 3: 175dpi bitmap image which has been scanned onto a doped piece of glass using a CO_2 laser with optical power stability control. Spot size is 176µ ±3µ and the image size 60 x 75mm.



More disjointed jottings

A Policeman's Lot

Peter Charnley

RE Cooke & Son (Burton) Ltd

Just as surely as New Year is a time for looking forward, so Christmas, for most of us, is a time for reflection on times passed – particularly Christmases passed. It's one of those annual occasions that has such cultural significance within our society, that we "save" the event onto the hard disk of our brain.

For reasons that made sense at the time, I broke my short, four year sales career in 1971 to join the H.M. Police Service as a Constable, which is a story in itself. I stayed in the force for a few years and was actually quite successful, but my theme today concerns my first Christmas as a policeman. I feel that the role of a policeman today is markedly different from that of 30 years ago; the pace is quicker, the environment much more aggressive and I sense that there is no space for fun any more.

I joined the Derbyshire force and was stationed within Derby for pretty well all my service. Life within a police station was hierarchical, with a very defined pecking order within the ranks. As the newest recruit on the ground I had certain jobs to perform that were not exactly within one's job description: cooking breakfast for the shift on a morning turn; picking up the local newspapers from the wholesaler on a day shift and collecting fish and chips and/or curries on a night shift. You get the idea!

The inner workings of a police station are a closed book to the majority of the population, but the reality is that most policemen want their place of work to be a pleasant, warm and comfortable environment. Thus the policemen who are gardeners will bring the odd bit of colour into the (back) office with bunches of flowers in the spring/summer. Family photographs can be seen, together with children's naïve attempts at art – no different to any other office environment. At Christmas time, I was to learn, a very special attempt was made to catch the festive spirit with a tree and office decorations. (It was actually quite competitive, with local stations each trying to out-do the others' efforts.)

What I hadn't realised until the early part of December 1971, was that it was my job, as newest recruit, to actually obtain the holly and tree for the police station. My sergeant was very clear: the holly leaves should be perfect, and there must be a surfeit of berries, which should hold until Twelfth Night.

That seemed a fairly straightforward shopping list, and I innocently queried which market stall we approached to secure these things without cost. (I had quickly learned that, as a policeman, you bought nothing!) It was the start of the night shift, with all my colleagues around, and they simultaneously burst into laughter. The holly didn't come from a market stall, I was told, but fresh from the ground; my job was to locate the ground, obtain the goods and bring them back to the police station before the end of the shift. I sensed that my next question would bring new laughter: which ground? The laughter came, and when it was quiet enough to get a word in, my sergeant pointed out that I'd got a few hundred thousand acres of Derbyshire to have a go at or, he offered a little conspiratorially, there might even be some posh houses "near your beat" that have large enough gardens to not miss this sort of "shopping". I was going to ask if that wasn't stealing…but thought better of it! I'd been the subject of enough humour for one night.

I set off at about 10:30 p.m., complete with secateurs and wood saw. Ringing in my ears was the universal endorsement of the shift, letting me know that last year's efforts at decoration was the best yet, and that the holly had been perfect. The constable responsible for getting last year's holly, (last year's probationer), was in the group, and indulged himself in a lot of self-congratulatory praise. He knew, he said, exactly where the "choice" holly was to be found and no, he wouldn't help me! After all, he said, it was something of a tradition that the probationer used his initiative in these matters. Besides, he unhelpfully pointed out, everyone in the assembled group had had to do the same thing in years past. They left me in no doubt that I had my work cut out, to match the quality and quantity of last year's holly; a daunting task as far as I was concerned, because the "rules" seemed to exclude anything as simple as actually buying the stuff legitimately.

But where was I going to get this holly and tree? The hint from the sergeant had been clear enough. Although my beat was located in what we would call today a deprived inner city area, the adjacent beat took in an affluent area that encompassed some rather large houses, each set in acres of garden. It was worth a look!

It's funny how you become alert to something when you need it. I'd driven and walked around this beat for several months, and never seen holly or small fir trees. But now, I was seeing holly everywhere, and small fir trees too. I parked my panda car on a number of occasions, and walked along the edges of properties to assess the quality of likely candidates for collection. I remembered well enough the criteria for the holly – "deep green leaves, no brown edges, and lots of berries." The trouble was that I was either finding the right quality of leaves, but no berries; or else masses of berries but discoloured leaves! I was determined to at least match the fabled quality and quantity of last year's effort, so I wasn't going to settle for second best!

Then I saw it: The perfect holly bush! Imagine if you will a big house with a long drive leading up to its frontage. Along the driveway were established trees and shrubs, and just in front of the house was large holly tree, beautifully coloured and covered in berries. A large lamp that illuminated a portion of the house for security purposes helpfully illuminated the tree too. Surely this was no coincidence? That this holly should even be illuminated and visible from the road must be some sort of divine providence, pointing me to my goal? By now it was about 2:00 a.m., and I felt a surge of relief, knowing that my quest for the grail was at an end.

Because it was a holly tree, not a bush, I knew that I couldn't reach the higher branches without help. So, using only the clutch, I backed the police car very slowly up the driveway. I opened the boot, stood in it, and got out my secateurs. This holly was perfect, and I could almost see the look of satisfaction on the sergeant's face as I imagined myself handing the contents of my night's endeavours over to him. I fancied, too, that I could hear the satisfied comments from the shift, as they let me know that I'd done a good job. Spurred by the inner glow that these imaginings brought on, I reached up to make the first cut, but was interrupted by the opening of an upstairs window, about three or four feet from my helmeted head.

The householder, in his pyjamas, recognised me as a policeman, and was visibly relieved that I was not trying to steal anything! (The irony will not be lost on the reader, I'm sure!) However, he was naturally curious as to what a six foot policeman, replete with helmet, whistle, truncheon and handcuffs and holding a pair of secateurs was doing standing in a Panda car boot backed up to his property. Good question! Unfortunately it was not a question that my three months' at police training school had equipped me to answer. I went into "sales mode", and the creative side of my imagination took over. "It's that cat up…..oh it's gone! You see sir, we had a report of a lost blue Persian cat, and your security light picked it out in the tree as I was driving by. I just happened to have a pair of secateurs in the car (!) and got them out in case I needed to clear a small branch – I hope you don't mind?"

The householder was visibly going through a long, extended moment of denial. The evidence of his eyes suggested that this was a policeman who was out to nick his holly…but a policeman stealing? Surely not? Like any good salesman, I recognised that this was a good time to terminate the interview, so I made some vacuous comment or other, apologised for interrupting his night, and hi-tailed it off his property. Talk about feeling stupid!

I drove out into the countryside and quickly discovered that the indigenous flora of Derbyshire does not include holly. Heather? You can have as much heather as you want, but holly and fir trees must be the product of other counties. I was in despair. My shift finished at 6:00 a.m. and it was now around 4:00 a.m. I drove back into Derby feeling utterly depressed at the thought of the humiliations that I was going to have to face in an hour or two. I hadn't had a drink or any break for the whole of this wasted shift, so decided to look for a cup of tea on one of the market stalls, which were starting to come to life.

So it was, mug of hot tea in hand, that I saw a sight that gladdened my heart. I felt like Paul on the road to Damascus; and my countenance changed from that of a failed, useless felon to one of successful entrepreneur who sees his chance in business. The lorry that was backing up to the adjacent fruit and vegetable stall was loaded with perfect holly – berries and all – and five foot fir trees which had clearly just been cut, sap dripping.

I really didn't mind that I was going to have to pay my own money for the holly and even decided to buy a tree as well; the important thing was that I was going to actually have holly and a tree too to take back to the police station! I walked up to the stallholder, and enquired the price for a boot full of holly and a tree? The deal was done and as he helped me put the generous portions of holly in the boot and back seat as well, the stallholder asked which police station I was from. "Oh, he said "this is getting to be quite a tradition; I supplied your lot with holly and tree last year as well. Do you think you'll be back next year?" "You can be sure of it!" I replied, feeling rather smug with the knowledge that I'd just obtained.

When I off-loaded the car at the police station there were grudging comments about the good quality of the holly, and a few "ooh's and ah's" when the tree got brought out too. "But," said last year's probationer and my tormentor, "I don't think that that holly's anywhere near as good as what I got last year!" "Can't think why," said I "because it's from the same place." He looked into my eyes, and saw that I knew that he'd visited the market too. "Perhaps you're right," he said, "now I look at it, I think it is just as good as last years." I handed the secateurs and saw back to the sergeant, who studied them with a forensic eye. "You'll make a good copper." He said. "You've managed to saw a fir tree without leaving a mark on the rusty face of this saw!" His face slowly broke into a grin, and he winked.

I'd completed some arcane rite of passage and from that point on I was accepted as a fully-fledged member of the crew. I was to have a few more Christmases as a policeman, each with a memory, but what always makes me smile is that there's a family in or around the Derby area that might share my memories of Christmas 1971, as they recall the night that they discovered a copper acting suspiciously on their property!

The *Industrial Laser User* needs YOU!

Something to share?

- News items needn't be long. A paragraph or two, preferably with a picture can be enough.
- 'News worthy' should be seen in the context of the laser community, not the public at large. New equipment, new contracts, a change of staff or premises are all examples of suitable news items.
- The scope of news items includes new laser-related products and services.
- We are keen to consider including edited versions of conference papers and project reports.
- We are interested in all aspects of industrial laser materials processing applications: financial and management as well as technical.
- We will do all the spelling and grammer checking and will present your paper for maximum impact.

Let us have your news and views!

Food for thought.....

Sub-contract part manufacture by laser deposition?

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As with many other laser techniques that have been developed by universities, government research labs or by laser equipment manufacturers, industrial uptake of the technology for laser deposition of metal powders is proving to be slow. Why should this be?

Is it because the cost of equipment is too high? Is it because the process is not technically viable? Or perhaps, is it because the market place does not really have a need for the process?

The first thing is to understand is that the process goes under a variety of different names, given by the originators of the different methods by which the process is performed. The term 'Laser Consolidation' is used by the National Research Council of Canada (NRC) while Optomec Inc.(Albuquerque NM, USA) uses the term LENS (Laser Engineered Net Shaping). Both of these originators license their process. The University of Liverpool, the University of Michigan and several other organisations have also researched the process in depth and use other names for what amount to similar methods. At this moment, the best surface finish is achieved by NRC's laser consolidation process, as shown by photos in this paper.

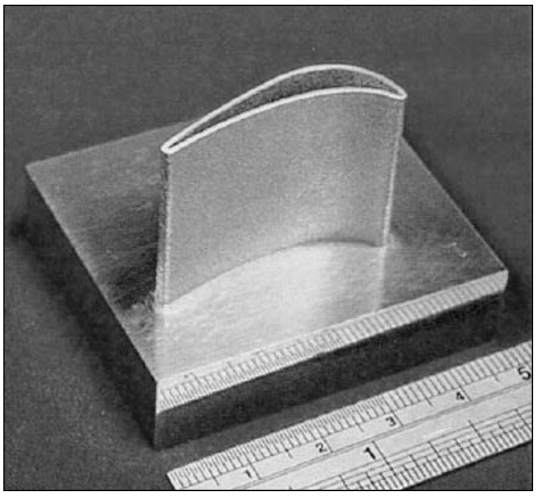
The attractiveness of laser deposition of metal powders is that parts can be generated directly from CAD models without recourse to hard tooling. The CAD models are 3D representations of the part, sliced horizontally, the height of each slice corresponding to the thickness of the molten metal layers deposited.

For thin-walled parts the ideal requirement is to retain a fine surface finish in conjunction with a tight dimensional tolerance. This also helps to create a structure that is metallurgically sound, internally as well as externally. For fine-walled structures an outer surface that requires no further finishing should be attempted, but for components that do not require a good surface finish (i.e. where a degree of roughness can be tolerated) then a faster build-up rate can be used to produce the parts more economically.

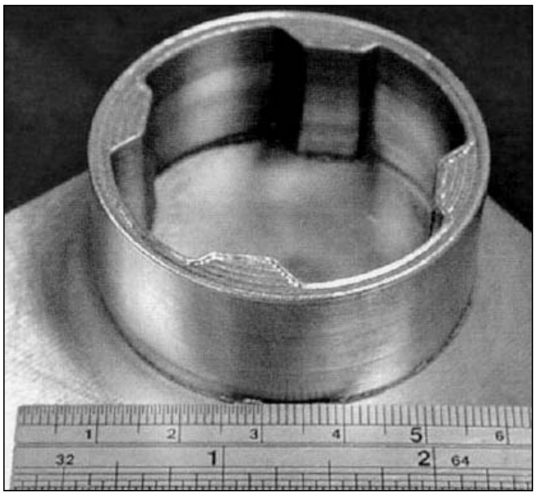
The above process requirements are based on the assumption that the deposition powder is itself free from porosity and cracks. The types of alloys that are currently being investigated are stainless steels, Ni-based superalloys, tool steels, Cobalt-based stellites, bronze and titanium alloys. More recent research has been directed towards the use of aluminium alloys; these present the more challenging processing problem of preventing oxidation of the powder during deposition. More difficult elements such as tungsten and rhenium are also being looked at.

The CO_2 laser is commonly used for deposition where surface finish requirement are not demanding, where there are demands for a high deposition rate to reduce costs, or where a good quality of surface finishes can be achieved locally by post-machining.

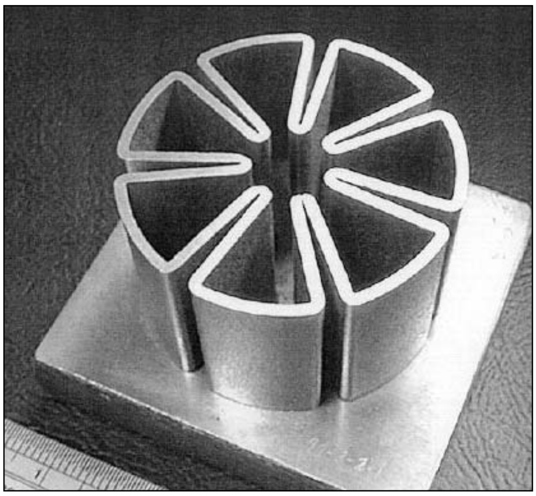
Manufacture by laser deposition



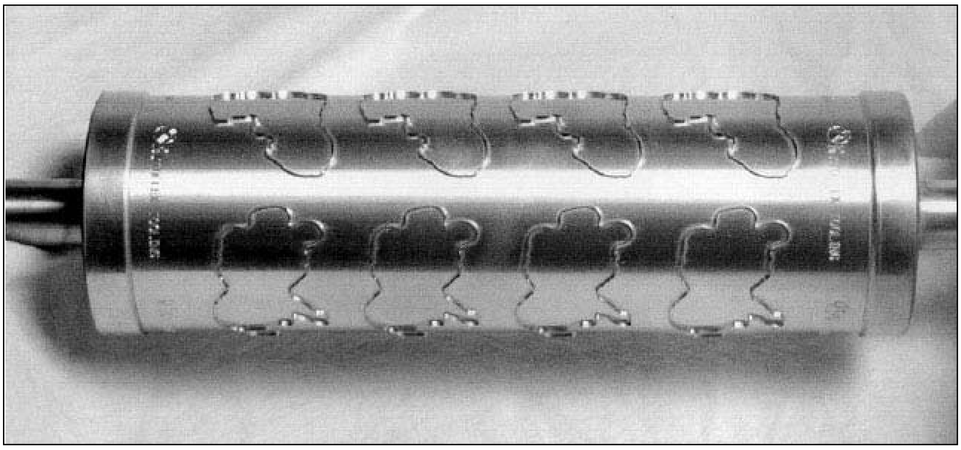
aerfoil in Ti-6Al-4V



cylinder with internal lugs in In625



petalled shape in Stellite 6



This rotary cutting die was made using powder metallurgy (PM) alloy tool steel powder to build the cutting blades only.

By contrast, Nd:YAG lasers are used to produce parts with higher quality finishes but achievable deposition rates at the present time are lower.

So, what might be the next area of laser application for this technology? There is a growing need for fabricating smaller parts with finer dimensions, for which a number of laser types could make attractive deposition sources. This includes the new sealed CO_2 lasers that operate in the 9.2-9.5 µm range, providing around 200W output with very short pulse lengths and high pulse rates. Gas and solid state lasers with output in green (e.g. the CVL at 532nm) light, short pulse duration and high pulse repetition rate might also be used. .If such lasers were configured multi-mode and the optical delivery system included galvanometer mirror control then this might yield interesting results.

At the present time, the machine tool part of a power deposition system is usually fairly standard e.g. a 5 axis stage with the Z-axis controlling the height of the focused beam above the part surface. The fourth and fifth axes are rotary and are mounted on the linear Y axis.

The powder deposition area is generally sealed to provide a controlled atmosphere, in order to maintain the desired material properties: machines are being built today that have a full working envelope of one cubic metre or larger.

Deposition powder is easily available and of good quality, and the recent introduction of nano-powders is interesting.

The other essential element of the power deposition system is the computer-controlled powder feeder. It uses either a screw or a vibratory feed mechanism to provide an a controlled flow of powder required at the nozzle. Nozzle design is perhaps the most important aspect of the system and is also the most challenging element of the system design.

What are the costs involved? The cost of a power deposition system is comparable to that of a normal 5axis machining centre but with the added cost of a special enclosure and a computer-controlled feeder. If the user is already in the laser processing business then the extra cost of the CAD software is nominal, and if the company is already involved in 5 axis machining then it is not difficult to add the post processor for extracting the laminar sections. The major cost of entry is the time it will take to learn how to do the deposition and here there are two principal options.

(1) License the process and pay the fee up front.

(2) Buy the equipment and develop the necessary skills. In this second option the real cost is in the metallurgical evaluation if, for instance, the intended market is aerospace components.

Is this process economically viable? If the market is defence, aerospace or medical components then the answer is likely to be ‘yes’. However, for other markets the answer is not so clear, and depends largely on how far the deposition parameters can be increased.

The metallurgical and mechanical properties that can be achieved by the deposition process are excellent. much of the data for various laser deposited materials can be found in technical papers. For example, the yield and tensile strengths of as consolidated Ti-6Al-4V material are around 1060MPa and 1160MPa respectively, significantly higher than as- cast or annealed wrought Ti-6Al-4V and comparable to the heat treated wrought Ti-6AL-4V.

All things considered, serious thought should to given to implementing this process.

The position reflected in this article is of the authors alone. The author would like to thank members of the Material Addition Processes Group, Integrated Manufacturing Technologies Institute, NRC of Canada. for allowing the use their photographs to illustrate the types of possible applications as well as the mechanical test data.

Machining of optical fibre components

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Companies involved in telecommunications are learning that technological achievement does not necessarily convert into commercial success when the speed of progress exceeds the market growth. However, the growth in demand, running at a rate of >100% p.a., would still be considered healthy by most measures. In the Western world, although people may these days be generally happy with the speed of their computer, the same is not true for their internet connection. Add to this the relative paucity of infrastructure in the developing countries and healthy growth looks assured for years to come.

Despite the high-profile commercial woes of some of the players, the recent developments which allow up to 100 channels of information to be transmitted each at 40Gb per second for hundreds of kilometers down a single optical fibre represent a staggering achievement. Although this has required advances in many technologies and materials, perhaps the single most important material which has made this possible is the (relatively) humble optical fibre. Generally made from quartz, the optical properties of the material and the fact that it is cheap, small, immune to EMI and can be readily manufactured in multi-kilometer lengths makes it ideal. Over 20 years ago it was claimed that quartz fibres were great for transmitting information, but the problem was with what to do with them at the ends. In very large measure, and after billions of pounds spent in this area, this still applies today.

Getting signals into optical fibres presents a particular set of technical challenges. These are caused by two fundamental features. The first is the physical size of the active part of the fibre. In the majority of cases this is ~9µm in diameter, but can be as low as ~3µm. The second is the material itself. Conventional methods of working glass-like materials (e.g. grinding and polishing) are generally slow, multi-step, iterative processes which for the most part are limited to flat or spherical geometries.

In response to the need to process quartz fibres more quickly and with greater precision, OpTek Systems have developed a range of machines using the patented LaserCleave process, see figure 1.

Figure 1 – Typical LaserCleave fibre processing machine from OpTek Systems
Based around a standard platform and designed as fully integrated turnkey systems, LaserCleave machines can be configured either as a stand-alone manually fed production tool or for integration into a production line or cell

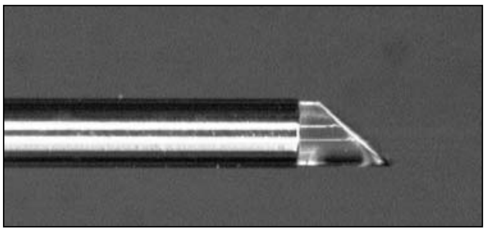

Figure 2 –The LaserCleave process can cut the fibre at almost any angle. Adjacent fibre metalisation is unaffected

This process, which is essentially a form of laser cutting, offers all the advantages one would expect a laser cutting machine to have over the conventional alternative. These include speed, precision, cleanliness and flexibility, as well as a number of other advantages specific to this application.

Cleaving

The best conventional method of severing an optical fibre is to cleave it. This involves making a small score on the surface of the fibre and then stressing the fibre until the flaw grows into a crack and the fibre breaks. This is exactly the same process you can see at your local glass merchant, and suffers from some of the same difficulties. The yield is less than 100%, the direction of crack propagation is somewhat statistical, the edges produced are very sharp and brittle, and it is impossible to cleave off very small increments.

In the case of optical fibres, the variability in the cleave angle that this causes and the inability to force the fibre to cleave at angles more than a few degrees from normal to the axis of the fibre represent major limitations to this process. However, the alternative method of polishing the fibre has even greater limitations.

Being essentially a laser cutting process, the LaserCleave systems can cut the fibre at any angle, including the optically interesting 0°, 7° and ~45°, see figure 2. The machines offer better than 0.2° angle reproducibility. The laser "cleave" produces robust rounded edges to the fibre, reducing the chance of damage during handling or insertion into other components. Moreover, the optical surface has a "flame polished" appearance, entirely free of scratches, cracks, digs, inclusions or contamination and has been measured to give superior optical performance to those produced by conventional cleaving (or indeed polishing).

What can be done on a single fibre can also be done on arrays of fibres (or ribbons), as shown in figure 3. Also, some of the geometries offered by the laser route, including saw-tooth cleaves and organ-pipe cleaves are just not possible by conventional techniques.

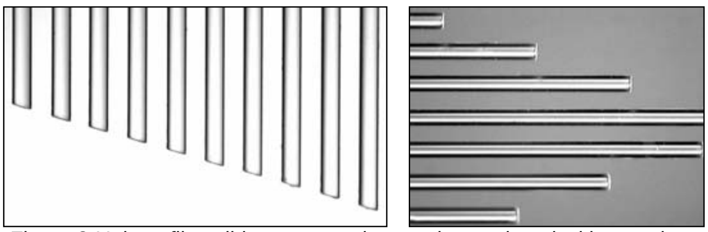

Figure 3 Unique fibre ribbon geometries can be produced with ease by the LaserCleave process

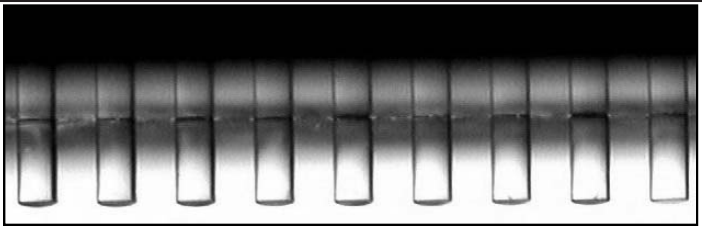

Figure 4 Fibres cleaved 250µm from a silicon block

In addition to the geometric, reproducibility and optical performance benefits, the laser route is non-contact. This reduces the chances of damage to the fibre caused by accidental scratching of the surface, and allows on-line QA and QC of the processed part, thereby eliminating the need for subsequent part inspection.

Laser processing allows these processes to be undertaken within or adjacent to other physical constraints such as v-groove arrays or ferrules, allowing completely new component designs to be realised. An example is shown in Figure 4.

The LaserCleave approach eliminates the time-consuming polishing step, removing the need for bulky mechanical support of the fibre and permitting higher packing densities.

Lensing

Lenses on fibres traditionally fall into two categories. Conical lenses are rotationally symmetric, and wedge (‘screwdriver-tip’) lenses are highly asymmetric, consisting of a one-dimensional “ridge” across the end of the fibre.

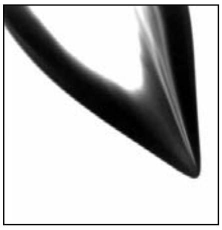

Figure 5 – Conical (symmetric) aspheric lens. The fibre diameter is 125µm and the tip radius 5µm with tolerances on dimensions and positioning <0.5µm

The LaserCleave process can produce both of these geometries with ease and speed. Tip radii can be controlled down to less than 5µm with centration errors less than 0.5µm. Over the ~9µm core of the fibre aspheric profiles can be produced, providing superior optical performance to spherical optics. Figure 5 shows typical conical lens tips on 125µm diameter fibre.

Many applications require asymmetric lenses. Conventional grinding and polishing techniques can produce cylindrical lenses which have a finite radius in one dimension, and a straight edge (effectively infinite radius) in the orthogonal dimension. This type of profile, shown in Figure 6 together with the resulting beam profile from the lens, takes many minutes conventionally but can be produced in seconds using the LaserCleave approach.

The conical and wedge lenses of Figures 5 and 6 represent the two lens profiles which conventional grinding and polishing has previously produced. However, the conic is only ideal if perfect optical symmetry is required, and the wedge is ideal only if no lensing at all is required in one of the two dimensions. In most real-life applications neither of these applies, and what is ideal is a lens with a radius of curvature which is separately controllable in the two orthogonal dimensions. This sort of lens, which we call biconic, can be readily produced by the LaserCleave technique and an example is shown in Figure 7.

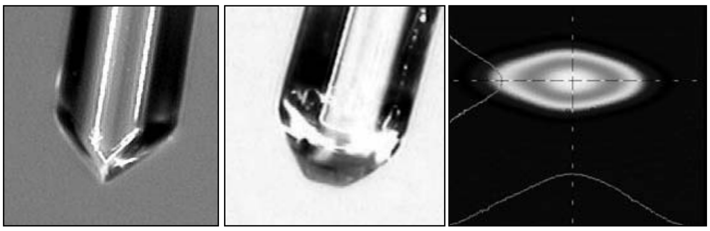

Figure 6 – Orthogonal views of the same “wedge” lens together with the resulting beam profile

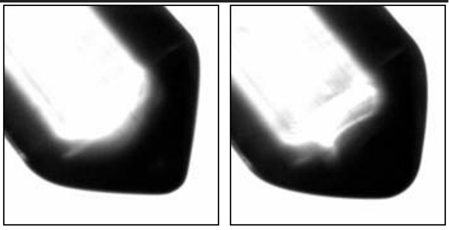

Figure 7 – Biconic lens, with separately controllable aspheric “radii” in the two orthogonal dimensions shown

The LaserCleave machines automatically ensure that the lens profile is centred on the core of the fibre to better than 0.5µm (even if the core is eccentric to the fibre outside diameter), as well as aligning the axes of the asymmetric lenses to the fibre axes in asymmetric polarisation maintaining (PM) fibre.

Lenses which take tens of minutes to produce by other means can be made in tens of seconds – with greater accuracy and reproducibility. Other lens forms which are almost impossible to produce by other means can be made in the same time.

Again, it will be no surprise to AILU readers that the laser route offers tremendous flexibility and fast product turnaround. Changing from one lens profile to another is simply a case of selecting a different recipe from the menu and takes <10s. Developing entirely new profiles can be done in minutes by changing the laser parameters and process steps.

Stripping

Most optical fibre has a protective polymer coating. Removal of this coating is necessary before many processes can be carried out. The LaserCleave machines are capable of removing this coating with speed and precision either as a stand-alone process, or as an adjunct to a cleaving or lensing process. Figure 8 shows the acrylate stripped to reveal the fibre both in the form of a small window (showing the excellent control over the interface between the stripped and un-stripped regions) and at the end of the fibre adjacent to the machining of a lens.

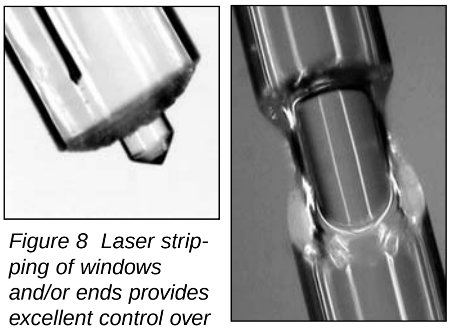

Figure 8 Laser stripping of windows and/or ends provides excellent control over the strip dimensions and the interface between the polymer and the fibre

Summary

After over a hundred years in which the processing of glassy optical components has remained largely unchanged, the development and introduction of laser processing has finally brought these processes in line with the machine-tool age. The machining of fibre optics is one example of how the speed, precision, and flexibility of this process is now being exploited around the world to produce components that perform better than those that can be machined conventionally. The same techniques are also being applied to larger components, as indicated in figure 9.

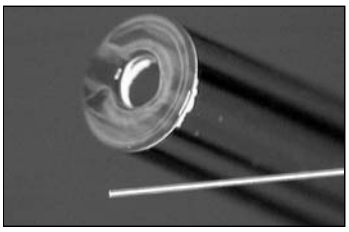

Figure 7. Laser machined capillary shown with 125 µm fibre for scale

Femtosecond laser beam quality for percussion drilling

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Laser micro-machining using femtosecond laser pulses has gained much attention in recent years. The reported ability to micro-machine features that are both cleaner and finer than those that can be produced with longer (e.g. nano-second) laser pulses has resulted in widespread interest in the application of the technology. Laser machining with longer pulses can result in a considerable heat affected zone (HAZ) and debris problems from melt ejection. By comparison, the primary benefits of femtosecond laser machining of solids include extremely rapid vapour formation and a negligible HAZ.

Good pulse energy and pulse duration are readily available in commercial CPA (Chirped pulse amplification) femtosecond laser systems. For percussion drilling with a femtosecond source, however, the most important parameter is the focusability of the beam. Excellent spatial quality of the beam will provide the highest power densities at focus in a more efficient and uniform manner than by increasing pulse energy alone. The reason for this is partly because power density at focus varies as the square of the beam radius and only linearly with the pulse energy and pulse duration. Laser beam aberrations must be minimised in order to secure a uniform spatial power density distribution and good focusability. Shortening the focal length of the focusing optics in order to increase power density will only work in part if there are unusable parts of the beam and, with such tight focusing it may not be possible to reliably reduce the pulse energy sufficiently to ensure that the materials processing is within the 1st ablation regime (see figure 6). In summary, for percussion drilling of micron range diameter round holes using femtosecond pulses it is important to work with a beam that is circular and of uniform intensity distribution.

Measuring the beam propagation factor (M^2)

The M^2 parameter of a beam can be described as a quantitative measure of how small the beam can be focused, as compared to a perfect (i.e. single mode) beam of the same diameter.

Certainly, there are many processes that can influence the spatial profile and the M^2 value of the beam from a femtosecond laser system. If the pulse is regeneratively amplified, for example, then the thermal stability of the stretcher and compressor gratings will affect the laser beam profile, yet measuring the M^2 parameter for femtosecond pulses is complicated by their high peak power. As a result, much debate surrounds the applicability of the ISO standard EN ISO 11146 ‘Beam width, divergence angle and beam propagation factor’ to the characterisation of femtosecond pulses and in the authors experience, the advice of suppliers has been to ignore the M^2 issue with femtosecond pulses and to concentrate on the machining results. Certainly, there are difficulties in measuring the M^2 for such high energy pulses and accounting for the non-linearity in the region of the focus, and measurements at the NCLA have indeed found machined features yield surprisingly good results in the light of a poor M^2 values estimated with the standard ISO measurement technique. For reasons of brevity, only a flavour of some of the issues with regard to the beam quality measurement can be given here.

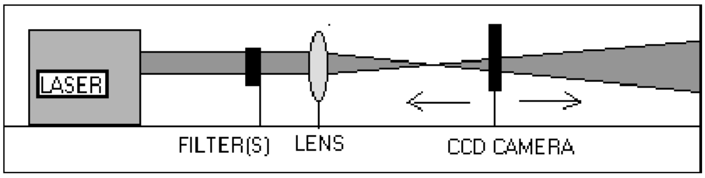


Fig. 1: Experimental arrangement used for measuring M^2.

Using the ISO 11146 standard since there was no better method available at the time of the study, two sets of measurements were performed, one set on the standard raw beam output, and one on the laser beam after it had passed through an external pinhole aperture. The basic arrangement is shown in figure 1. The output of the laser was sampled by a ‘DataRay Wincam’ CCD camera and attenuated with optical filters so that the peak response of the camera was the same at each position along the beam path. The laser beam was passed through a long focal length lens to the detector which was moved in steps along the beam path. At each position along the beam path the second moment beam diameter was measured in the x and y directions (D_x and D_y) and the average of three readings was taken for each data point presented. The data is graphed in figure 2. What is immediately evident from the graph is that the beam appears more radially symmetric after the beam waist position, which is at approximately 525 mm from the lens in the x direction, $Z_0(x)$, and 550mm in the y direction, $Z_0(y)$. Also, the x and y beam waists appear offset from one other i.e. the laser beam is astigmatic.

There is a great possibility for error in the measurement of the beam diameters at the waist of the beam, primarily because non-linear effects are significant in this region of greatest intensity and, of course, because where the beam diameter is smallest the

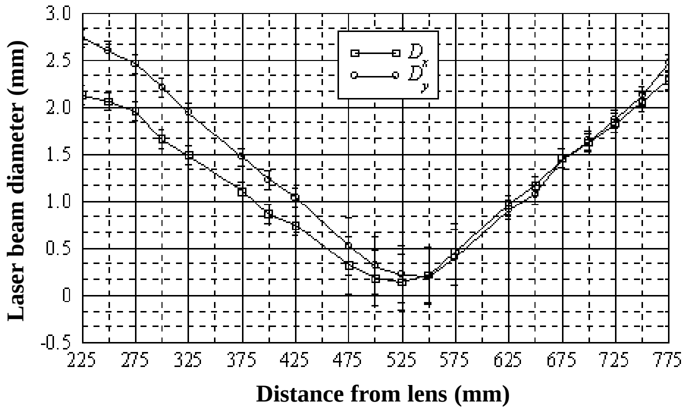


Fig. 2. Laser beam diameter in the x and y directions with propagation distance

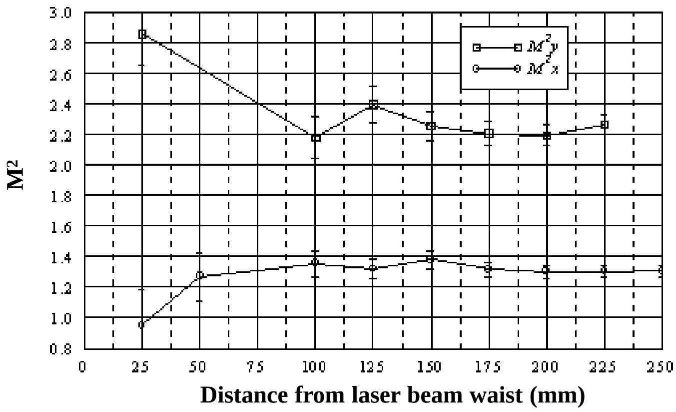


Fig. 3. M^2 of the "raw" laser beam with distance from the beam waist

resolution of the camera introduces the largest error and, despite the use of filters to attenuate the laser beam, saturation of detector elements may occur.

Evaluating the so called B integral for a typical femtosecond laser beam indicates that self-focussing, air breakdown and beam filamentation will occur at the focus. This is because the B integral for focused femtosecond pulses can far exceed the maximum permitted value of about 5 before non-linear effects kick in. When there is a non-uniform power density distribution in the laser beam above a certain threshold, different parts of the beam will propagate with different phase velocities because of the refractive index of air dependency on power density (In a non-linear medium such as air the refractive index will increase with power density above a certain threshold and create a form of waveguide), this in turn creates a self focusing effect as the rays propagate towards the region of greatest power density. Self focussing usually distorts the beam quality and blocks its propagation to some extent due to the air breakdown. However, we have observed greater roundness after the focus in the presence of air breakdown which suggests that there are other processes involved which are actually improving the "apparent" beam quality somewhat in the far field.

The M^2 values in the two directions were then calculated from a re-arrangement of the ISO standard formula:

$$M^2 = \pi D_0^{\,2}\left(\frac{\sqrt{(D_z/D_0)^2 - 1}}{4\lambda Z}\right) \qquad (1)$$

where D_0 is the diameter of the laser beam at the waist, D_z is the diameter of the laser beam at a distance Z from the waist and λ is the wavelength of the laser beam. These calculations were performed for positions in x and y outside the beam waist only, and they are shown in figure 3.

It is evident that the values closest to the beam waist show most discrepancy from the average values and the x and y beam waists have an apparent offset of 25mm from each other when using a long focal length lens. An error of ±12.5mm can be substituted into the equation for M^2 for each value along the beam propagation recorded to examine the relative errors with distance from the beam waist. When this calculation was carried out it was evident that the largest errors were indeed associated with the value nearest the beam waist, as shown in table 1. The other experimental points were found to be more consistent, and only values of M^2 relatively far away from the beam waist were used for the average calculations.

Within the range of experimental error the values of M^2 were found to be: $M^2_x = 1.318 \pm 0.131$ and $M^2_y = 2.276 \pm 0.218$ for the raw beam.

Distance from beam waists zx ,zy (mm)	M^2x	M^2x error	M^2y	M^2y error
25	0.950	0.475	2.857	1.429
100	1.355	0.169	2.181	0.272
125	1.318	0.132	2.395	0.239
150	1.379	0.115	2.252	0.188
175	1.317	0.094	2.205	0.157
200	1.302	0.081	2.194	0.137
225	1.301	0.072	2.265	0.126

Table 1: M^2 errors with propagation distance from beam waist

Spatial filtering

In a preliminary assessment of the potential benefit of spatial filtering of the laser beam, a pinhole of 3mm diameter was inserted in the beam path, before the focusing lens shown in figure 1. Whilst not operating as a spatial filter, the pinhole did transform the irregular power density profile of the beam into a more regular 'top-hat' beam and make the beam cross section more circular. This is illustrated in figure 4, which compares the "raw" beam profile with the 'pinhole' beam profile. The "raw" beam near field is seen to exhibit reasonable goodness of fit to a Gaussian distribution while with the pinhole the beam exhibits excellent roundness albeit with the introduction of some diffraction fringes.

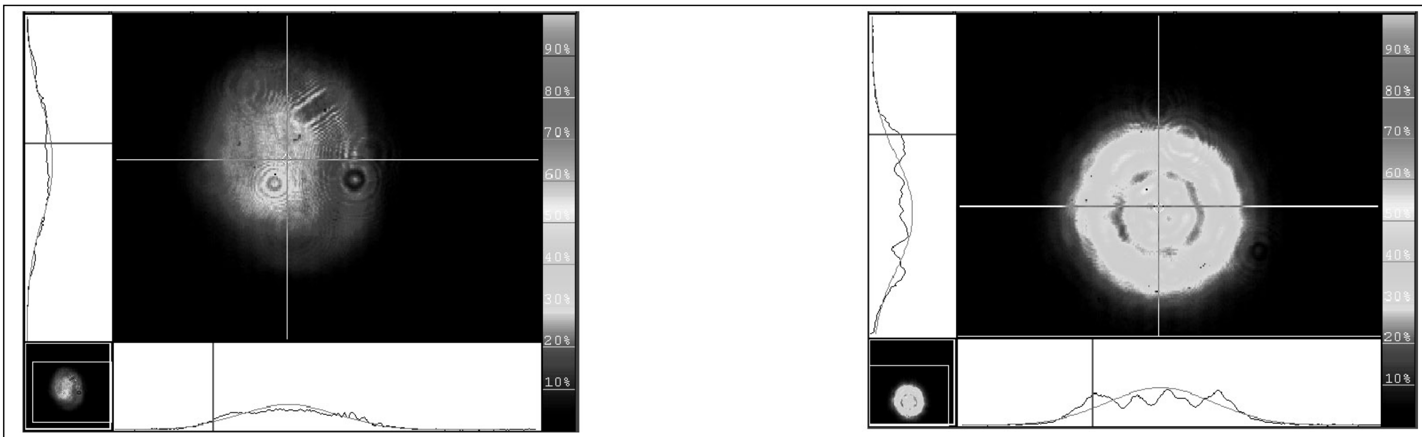


Fig. 4. Beam profiles (left) raw beam exhibiting ellipticity and (right) Pinhole-filtered beam exhibiting a more top hat profile and greater circularity

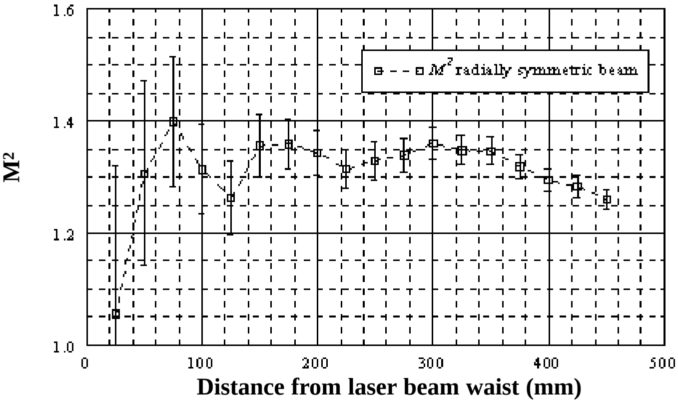


Fig. 5: M² of the "apertured laser beam vs. distance from the beam waist

When working at such high intensities with femtosecond pulses a 'top hat' beam profile can be useful, to provide a more uniform effect on the material over the beam area, especially to ensure that the power density over all areas of the beam is above the ablation threshold.

With the pinhole in place the degree of ellipticity of the beam was less then 15% at all positions along the beam path and the beam was deemed radially symmetric according to the ISO standard. Consequently, the calculations that follow assume a single value of M^2 for the laser beam. Using the same arrangement as in figure 1, the values of M^2 were obtained and are shown in figure 5. Ignoring the first data point which is again very close to the beam waist and has a high error associated with it, the average value for M^2 for the laser beam propagating through the pinhole was measured to be 1.325 ± 0.098.

Percussion drilling of through holes

For percussion drilling of micron range diameter round holes using femtosecond pulses it is important to work with a beam that is circular and of uniform power density distribution.In what follows a pinhole set-up was used to filter the beam as described above, though other potentially better methods, including spatial filtering and the use of adaptive optics, are currently under investigation for cleaning up the beam profile.

Ablation regimes

In short pulse laser machining of solids it is well known that there are two ablation regimes: a so-called low fluence regime (the first ablation regime) where the energy deposition into the material is of the order of the optical penetration depth, and a high fluence regime (the second ablation regime) where the energy deposition is greater and extends further into the material. The first regime is associated with negligible heating effects whereas during ablation

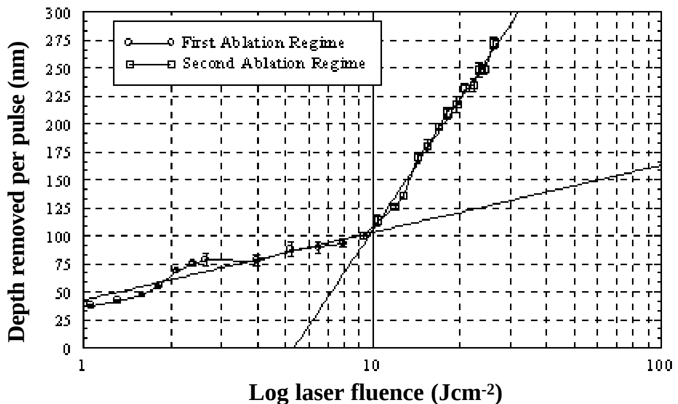


Fig. 6. Ablation threshold for stainless steel as a function of laser fluence

in the second regime thermal damage may also occur. The threshold fluence (Jcm-2) for material removal is higher in the second than in the first regime but in both regimes the fluence displays a logarithmic relationship with ablation depth per pulse.This is illustrated by the example shown in figure 6, from work carried out at the NCLA to characterise stainless steel.

In figure 6 the 'surface damage' threshold is about 0.17 Jcm-2 and the knee of the graph, the point at which the second ablation regime is approached, is at 10Jcm-2. For each material, exposed at the surface ablation threshold fluence, the ablation depth per pulse 'incubates' until, after a certain number of pulses have been delivered to the target, it reaches a constant value. The 'incubation' phenomena is at least in part associated with chemical reactions in the irradiation zone, such as oxidation, that can change the surface absorption. Also, in the early stages of machining, the evolving shape of a machined feature may influence the fluence distribution.

Practically speaking, high quality laser micro-machining using femtosecond pulse ablation requires operation in the first ablation regime i.e. the energy deposition is confined to within the optical absorption depth. Since typical optical penetration depths are of the order of a few tens of nanometres for metals, this means, of course, that the material removal depth per pulse will be small.

Hole drilling in 316L stainless steel

A particular application required the repeatable percussion drilling of holes with entrance dimensions in the range 8-30µm, in 316L stainless steel and a pure aluminium foil, of thickness 30 to 80µm.

In order to produce through holes it was found necessary to drill above the minimum ablation threshold i.e. the threshold fluence for producing through holes was above the minimum surface ablation threshold, independent of the number of shots to the target. This is presumably due to the influence of crater evolution on the surface fluence.

Fig. 7. Percussion drilled hole entrance in 80 µm thick stainless steel

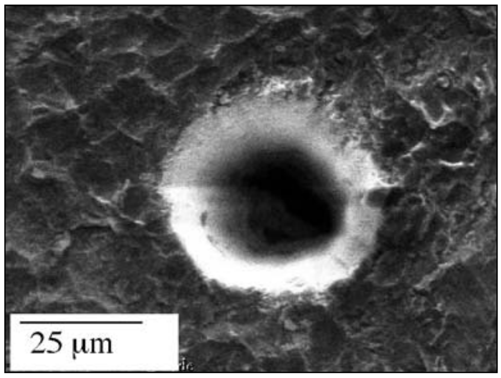
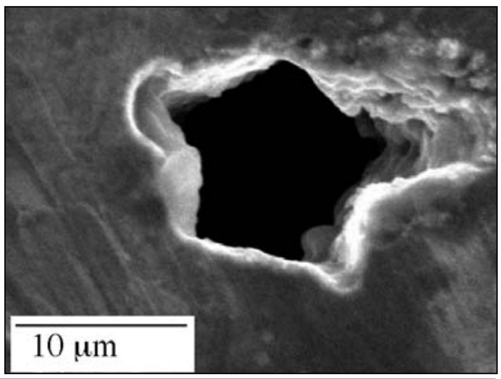


Fig. 8. Linear polarization effect on the circularity of an exit hole at a fluence of 8 J/cm2



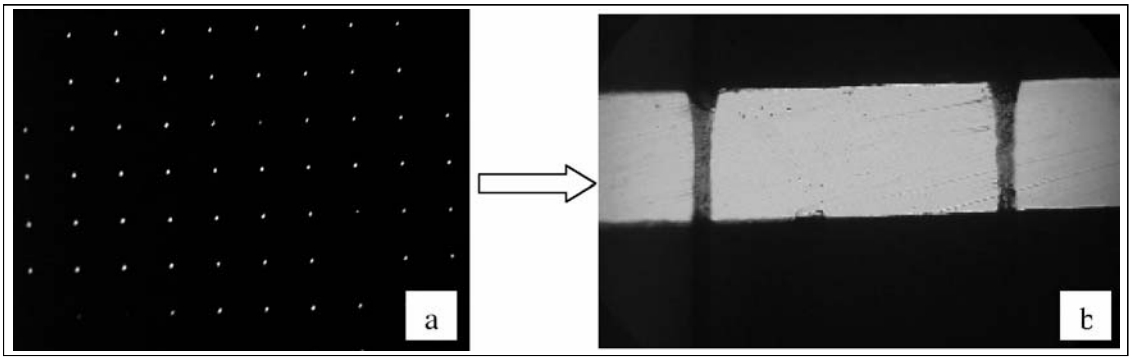


Fig. 9. Through hole drilling in stainless steel 304. Hole entrance diameter 15 µm, hole exit diameter 10 µm.
(a) x200 magnification
(b) x1000 magnification, Laser fluence 9 Jcm-2, Number of shots 500

Figure 7 shows a 25 µm percussion drilled hole entrance in an 80 µm thick stainless steel foil which was drilled with 150fs pulses at 1kHz for 500 shots with a required fluence of 8 Jcm^{-2} for breakthrough. The surface roughness around the hole entrance is minimal in this case and very little debris is deposited around the circumference of the hole. Upon breakthrough, the hole exit exhibits less circularity, a result we attribute to the linear polarisation of the beam and giving rise to a preferential absorption in one direction, leading to the characteristic cross-like appearance shown in figure 8. This phenomenon is exacerbated at the minimum ablation threshold but the effect can be minimised by rotating the polarisation of the beam during the drilling process (e.g. with a high speed rotary half waveplate).

Working at fluences just inside the second portion of the ablation depth / log fluence graph resulted in breakthrough and it was possible to percussion drill through holes in 50µm thick stainless steel 304 foil with high circularity both at the entrance and the exit without resorting to rotating the polarisation. This was also achievable whilst processing in air.

Figure 9 shows a matrix of holes with 15 µm entrance diameter in the left of frame and the cross sections of the same holes are shown in the right of frame with a 10 µm exit. The holes were produced at a fluence of 9 Jcm^{-2} and 500 shots. The matrix gives an idea of the repeatability and uniformity of the holes. A deliberate taper was engineered into these holes by means of a short focal length objective. The holes could be made parallel by the use of a slightly longer focal length objective in order to increase the depth of field.

Similar trials were carried out on a 30 µm thick pure aluminium foil and a repeatable matrix of holes with 8 µm entrance diameter and 4 µm exit diameters was produced with 250 shots at a fluence of 4.5 Jcm^{-2}. A white light interferogram of the matrix of holes drilled in the pure aluminium foil is shown in figure 10. The holes were produced Downsizing the holes further requires the use of shorter focal length objectives and work is ongoing to develop techniques for accurate high attenuation of the laser beam, to prevent excessive fluence on the workpiece under these conditions.

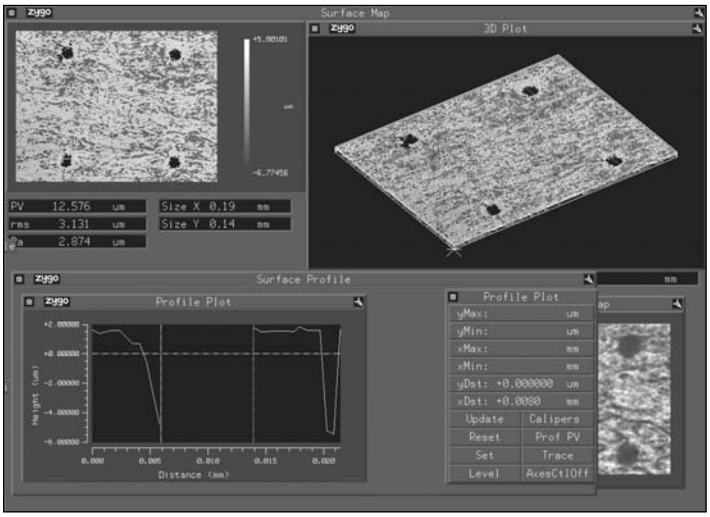


Fig. 10. Scanning white light interferometer image of an 8 µm entrance hole drilled in a pure aluminium foil 30 µm thick. The exit hole is 4µm diameter

Conclusions

A discussion of some of the femtosecond micro-machining work at the National Centre for Laser Applications, Galway has been presented. Difficulties of determining M^2 values for the femtosecond laser beam have been presented. The beam was found to be non-circular and astigmatic.

The use of an external pinhole aperture placed in beam was found to produce a radially symmetric beam of reasonable power density uniformity and an M^2 value of 1.325 ± 0.098 was measured.

Using the pinhole set-up the ablation threshold for a range of materials was determined and percussion drilling of through holes ranging from 8 µm to 25 µm in entrance diameter was performed on stainless steel and aluminium, with the aim of achieving features with minimal thermal damage. The machined holes were found to be of higher quality than examples available in the literature of holes drilled with longer laser pulses. The minimum threshold fluence for producing a through hole was found to be above the minimum threshold for surface ablation. Further details of this work can be found in The Proceedings of SPIE-OPTO Ireland, September 2002, and at http://www.physics.nuigalway.ie/ncla/apps_ultrafast.htm

The production of micron sized trepanned features is currently under development, using a high precision motion system.

References

1. ISO 11146:1999 Test Methods for Laser beam parameters: Beam width, divergence angle and beam propagation factor.

Hole taper control in laser percussion drilling

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In manufacturing industries, the aerospace industry in particular, small hole (0.1-0.8 mm diameter) drilling is carried out routinely using high power solid state lasers. One of the important issues is hole-taper control, particularly in laser percussion drilling whereby material is ejected in the form of molten droplets as multiple laser pulses are delivered to a point on a workpiece. Whereas zero taper is required in certain engineering applications and negative taper (entrance hole diameter is smaller than the exit hole diameter) is needed in others, the entry hole diameter in percussion drilling is normally larger than the exit hole diameter i.e. the holes have a positive taper. Laser trepanning is currently used for taper control, but the process is much slower than laser percussion drilling.

Melt ejection is the dominating mechanism for material removal in laser percussion drilling with 0.1-10 ms pulse width range. The process is illustrated in figure 1, which shows how repeated erosion occurs at the entrance of the hole. Figure 2 shows some experimental results illustrating the enhanced erosion at the hole entrance, leading to the conclusion that melt erosion plays an important role in hole taper formation.

A second contributing factor to the positive hole taper is the reduction in laser power down the hole, resulting directly from the divergence of the laser beam beyond focus and the absorption of the beam on the hole wall. Based on a simplified model of beam propagation down a hole(for more details of the calculation, see ref 1), the laser power variation over 2.6 mm drilling depth on Nimonic 263 alloy is shown in Figure 3. It is apparent from these results that the laser power density falls significantly down the hole.

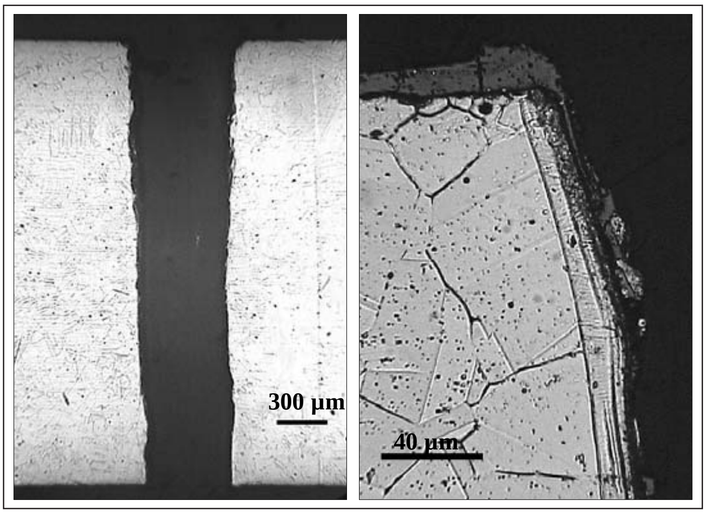

Figure 2. Cross section of a typical hole-taper characteristic during laser percussion drilling. (left) Full cross section (right) Close-up of the entrance wall cross section showing extensive erosion.

Reference 1 also includes a statistical model of the sensitivities of the hole taper to six independent input parameters: laser power, pulse width, pulse frequency, focal position, number of pulses and assist gas flow rate. The results for the Nd:YAG laser drilling process show that taper is most sensitive to focal position, since the focal position controls the beam spot sizes at various locations

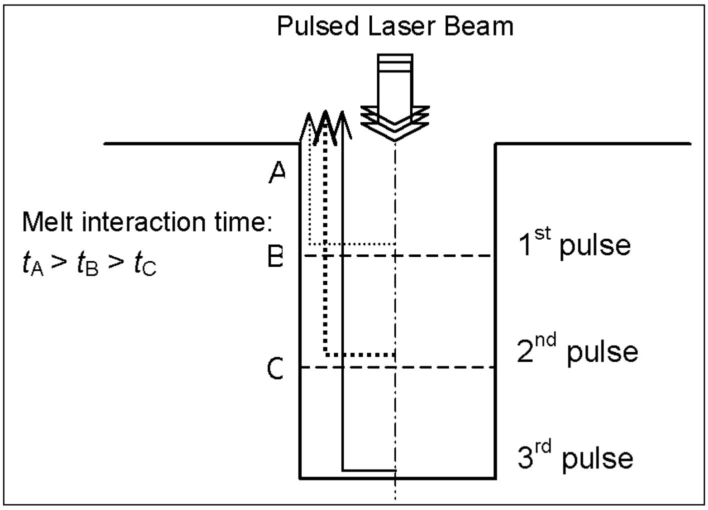

Figure 1: Illustration of the melt erosion effect in persussion drilling. The hole wall close to the hole entrance (point A) is repeatedly eroded by multiple groups of hot flowing melt as the hole deepens with successive laser pulses, whereas point C is eroded to a lesser extent.

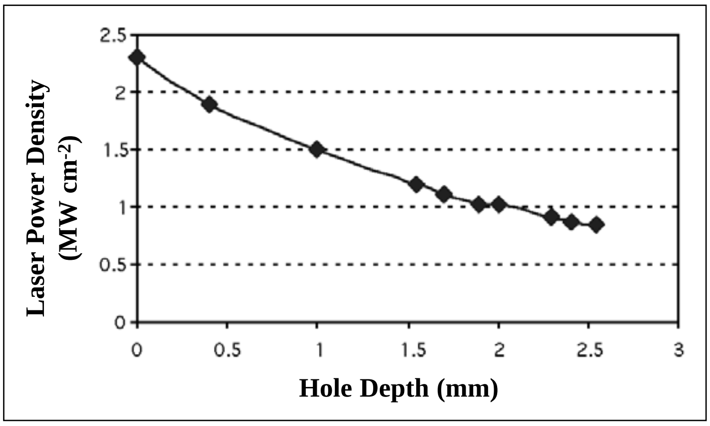

Figure 3: Calculated variation of laser power density at the base of a blind hole vs. the depth of hole at 1.06 µm wavelength (Nd:YAG) for Nimonic 263 material, over a 2.6mm drilling depth
The calculation assumes a cylindrical hole, with the laser radiation diverging and reflecting from the hole wall with a reflectivity Rm (=35.3% at 1.06 mm (Nd:YAG) for Nimonic 263 material). The power density at the bottom of the hole is made up from the unreflected (central) portion of the laser beam together with a contribution from reflections from a point half way down the hole.

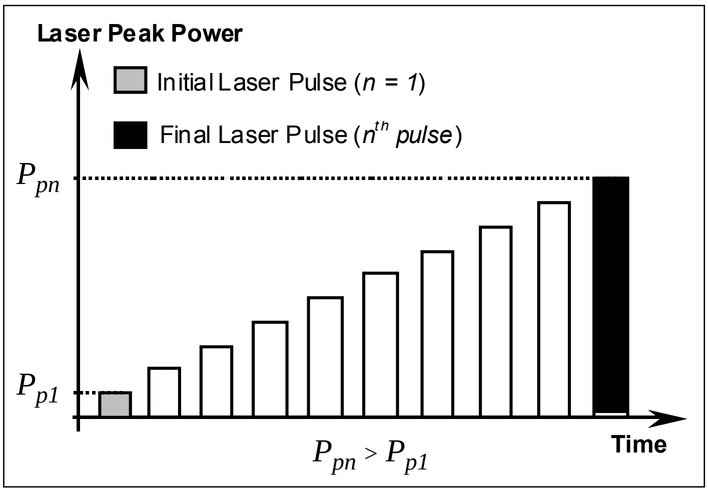

Figure 4. Schematic diagram of linear inter-pulse shaping.

in the hole. Peak power, pulse width and number of pulses, which together control the energy input to the material, have a lesser effect and assist gas and pulse frequency do not have significant influence on the taper formation. The model clearly indicates that varying process parameters alone may not be sufficient to achieve zero taper.

Hole taper control

Because of the non-uniform wall erosion by the ejected molten material and laser beam intensity variation over the depth of the hole, taper formation is unavoidable if identical pulses are used for the percussion drilling. To compensate for these effects, an inter-pulse laser beam shaping technique was developed. A feasible method found was to linearly increase the laser pulse energies throughout the pulse train (by increasing the peak power) as shown in Figure 4, where power density is increased between pulses to compensate for the power losses down the hole.

To verify the control strategy, experiments were carried out using both linearly increasing and linearly decreasing inter-pulse pulse shaping. The laser used to perform the drilling experiments was an Electrox Scorpion fibre-optic delivered Nd:YAG laser. The laser beam was focused onto the material surface with a 120 mm focal length lens, giving a spot size of approximately 0.52 mm. A coaxial O_2 assist gas (40 l/min) was employed through a 44 mm long conical nozzle. The nozzle-workpiece distance was kept constant at 2.2 mm. The material investigated was Nimonic 263 alloy (2.65 mm thick). A typical result is shown in Figure 5 where holes with zero and negative tapers (Figure 5 a,b) were drilled with linearly increasing pulses and the hole with positive taper (Figure 5c) was drilled with linearly decreasing pulses.

By comparison with percussion hole drilling at a constant pulse energy, with linearly increasing pulse shaping the initial pulse produces a smaller hole and during followed pulses the hole enlarges, with melt flushing through the hole exit when exposed to the higher power pulses towards the end of the pulse train. A measurement of melt ejection showed 32-38% melt ejection from the exit end of the hole for the linearly increased pulse training drilling as compared to 20-25% melt ejection from the exit end for the holes drilled with constant pulses under the same total deposited energy.

Drilling holes using constant pulses resulted in hole tapers of 11-18% (or 1.4-2.2 degrees) for the materials tested, whilst zero taper holes were produced using linearly increasing pulse trains with the same total energy input.

The work has shown that by using variable pulse energies for percussion drilling, not only can the laser power at different depths can be controlled but also the amount of melt ejection from the hole entrance and hole exit can be controlled.

Summary

Non-uniform melt ejection erosion to the hole walls and laser power reduction as the beam propagates through the hole have been identified as major contributors to hole taper formation during percussion drilling. Statistical modelling has identified that hole taper is most sensitive to focal plane position variations followed by pulse width, peak power and number of pulses. A new approach of drilling with variable pulses (inter-pulse shaping) rather than identical pulses has been demonstrated. The new process has been shown to be able to produce zero-tapered holes as well as positively and negatively tapered holes.

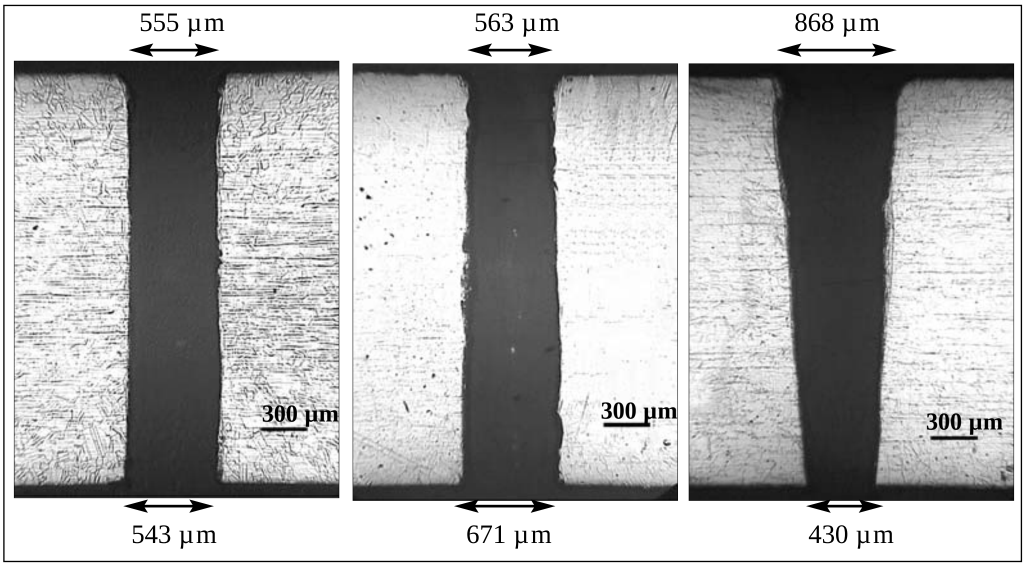

Figure 5. Various tapered holes drilled using variable pulse percussion laser drilling technique. (a) “zero” taper, (b) negative taper, (c) positive taper.

Acknowledgments

The authors acknowledge the financial support of some of the work by Rolls-Royce Plc.

Reference

1. ‘Hole Taper Characterisation and Control in Laser Percussion Drilling’ by L.Li et. al. Annals of the CIRP, Vol 51, Issue 1 2002 p153 - 156

Practical Laser Cladding with High Power Lasers

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Tim Weedon comments: Even on the last afternoon of ICALEO, Trevor's presentation had the power to stimulate the audience to close attention. Of all the presentations I heard, this is the one I would select as most likely to inspire AILU members.

In the discussion on his paper, Trevor was asked whether the life of the laser-clad components was better or worse than the two years of those produced by the previous process. His quiet response was: "We do not know; the process has been running only three and a half years and we have had no failures yet."

Laser cladding is used primarily in the surfacing of metallic components to provide increased wear and corrosion resistance. A multi kilowatt CW laser beam is applied normal to the surface to melt both the coating alloy and a thin layer of the substrate, to form a fully dense, metallurgically bonded coating. The coating material is usually delivered to the melt pool in powder form by means of a carrier gas. As the laser beam moves across the substrate surface a fully dense bead of the coating material, typically 3 to 5 mm wide and 1 mm high, is fully bonded to the substrate. To achieve surface coverage, consecutive individual tracks are overlapped, usually by 50% to 60% in order to minimise surface roughness.

Jarvie Engineering has recently acquired two high-power CO_2 laser-cladding systems for the surfacing of mining components. The 5kW and 6kW systems have been commissioned and are now operating two shifts per day depositing a range of powder alloys on various components.

Introduction

When engineers design or select plant and equipment for a particular purpose, it is a difficult task indeed to ensure that all of the components within that system are fit for purpose. Manufacturers of equipment for use in the mining industry would normally design machine components for high performance in harsh conditions, but advanced equipment users are in constant pursuit of higher productivity, and higher reliability. This may result in parts being subject to conditions of greater load and speed, increasing the risk of wear leading to failure. Environmental service conditions can also vary dramatically from one industry site to another, strongly influencing the type of wear and corrosion that will occur.

Since wear and corrosion processess can be site specific and influenced by so many variables, there is no simple formula available to an engineer that can provide all of the answers at the design stage. It is often left to the maintenance engineer when failure occurs, or warranty is exhausted, to re-engineer worn or damaged components, especially where a shortage of suitable replacement parts or financial constraints influence the decision. Capital restraints can result in old plant being up-graded rather than replaced, often prompted by access to new technology and processes. As most wear and corrosion affects the surface of a component, the science of the surface is very important when selecting a surface engineering solution. It is necessary to reassess the component, the application, and the environment that it will be operating in. It is also important to be aware of the various types of surface processes, their benefits, and application areas. It was this awareness in relation with a customer problem, the corrosion of leg cylinders in underground coal mining, which prompted Jarvie Engineering to introduce commercial laser cladding to Australia.

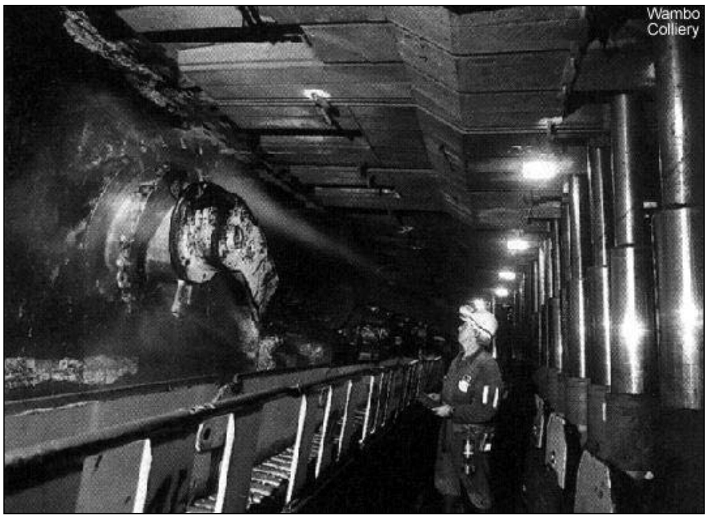

Figure 1. Coalmine supports (above)Longwall Shearer and Roof Supports.
(right) A single Roof Support

Background

Australia is the worlds largest exporter of black coal, most of which is mined on the eastern seaboard in New South Wales and Queensland. Much of this coal is extracted from 31 underground mines using a method known as "longwall". In longwall mining, large rectangular blocks of coal are defined during the development stage of the mine and are then extracted in a single continuous operation. As the coal is cut, by a mechanical device known as a "shearer", the longwall face is supported by hydraulically operated supports. The function of these supports (shown in fig-

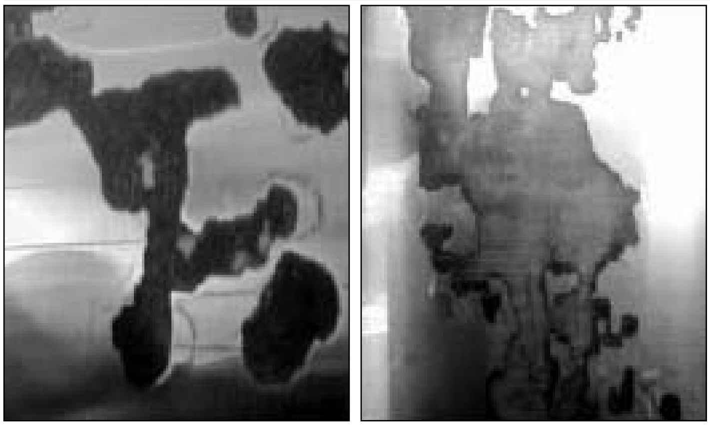

Figure 2 Exfoliation of coatings caused by acid attach of the underlying substrate.
(left) Cr on Steel
(right) Cr on bronze on steel

ure 1) is to provide a safe working environment by supporting the roof as coal is extracted, as well as advancing the longwall equipment. As the face advances the roof immediately above the coal is allowed to collapse behind the line of supports.

The forces required at the support line to control strata deformation are supplied by a set of double acting, double stage hydraulic leg cylinders each with a capacity of 200-500 tons. There are two or four cylinders on each roof support, and up to 150 roof supports on each longwall. The sealing surfaces of the alloy steel hydraulic cylinders are usually electroplated chrome or bronze, or sometimes a combination of both. Due to the damp and dusty environment underground, the exposed sealing surfaces of the hydraulic cylinders become progressively coated with an adherent organic mixture that contains dilute acids. If the surfaces are not cleaned frequently, the acids will penetrate the coating and attack the underlying substrate causing the coating to exfoliate, as shown in figure 2. Over time the damaged surfaces cause the gland seals to leak, eventually resulting in pressure loss and risk of system failure.

Corrosion often penetrates deep into the substrate, and the full extent of the damage may not be realised until the electroplating is stripped from the surface. Due to the depth of the damage, electroplated coatings are no longer recommended for the refurbishment. The components either have to be scrapped or the original design specification requirements be revised to incorporate a new surface engineering repair process.

After many months of research and trials with alternative coating processes including arc welding, spray coatings, and polymer impregnation, Jarvie Engineering decided that a process audit, followed by a component reverse design audit needed to be conducted to ensure process and product integrity. The main elements of the process audit related to the following items:

- Component preparation requirements prior to coating application.
- Ease of handling of the component during process stages.
- The effect of preparation processes on the physical strength of the component.
- Metallurgical changes to the substrate.
- The introduction and interaction of the coating on the mating surfaces
- Characteristics derived from the coating.
- The cost effectiveness of the finished product.

Selection of Process

Of the many coating processes available, laser cladding was selected because it offered the unique combination of qualities necessary to meet the requirements established during the design audit. The prime consideration was the ability of the laser to produce a low-heat metallurgically bonded coating that had minimal effect on sensitive alloy steel. The properties of the base material were not to be compromised, and the coating was required to contribute to the structural integrity of the assembly, rather than detract from it. There was a requirement to apply in one operation both thin and thick coatings depending on the extent of the corrosive damage. The process required the deposition of a coating that could stand up to the extreme dynamic loads and aggressive conditions experienced underground.

From a manufacturing and handling point of view, the laser process is ideal for the following reasons:

- Adaptable to full computer numerical control.
- Suitable for application to rough machined surfaces.
- Needs no special post machining preparation.
- Accurate, strategic deposition.
- Many metals and alloys can be deposited.
- Can be machined and finished using conventional tooling and methods.
- No post weld heat treatment is necessary.
- Fast turn around.
- Suited for both light and heavy deposition.
- Precise quality control.
- No chemicals are necessary.
- Environmentally friendly.

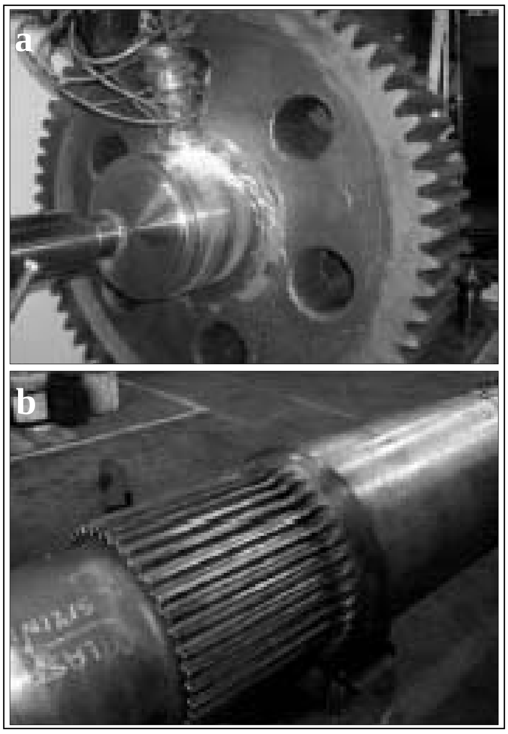

Figure 3. Some typical examples of laser cladding applications in Australia.

(a) Laser cladding gear journal utilising a co-axial cladding head. The bearing and oil-seal diameters of these components are prone to wear and fretting due to heavy dynamic loading. Resurfacing by laser provides the low heat input qualities required to ensure dimensional stability.

(b) Laser spline rebuild. On a typical shipper shaft, the rebuild extends the life of an otherwise scrap component. No heat treatment is applied after laser welding.

Selection of Coating

Most metals and metal alloys can be applied as coatings, but their metallurgical properties and the coating-substrate bond often limit the applications that they are suited to. The coating process must be fit for purpose, and in the case of the leg cylinder a full design audit was undertaken, addressing the following qualities or influences of the coating and the process application, at the surface interface and on the finished component:

- Coating bond strength
- Shear performance
- Tensile and compressive strength
- Effect on the substrate
- Surface preparation requirements
- Mechanical properties
- Sealing and sliding properties
- Lubrication/frictional behaviour (water emulsion)
- Hardness
- Ductility
- Resistance to impact (coal and stone)
- Resistance to tribological stresses
- Compatibility with hydraulic seals and media
- Behaviour under pressure
- Adaptability to corrosion
- Thermal stability
- Biocidal stability
- Coating thickness constraints
- Ease of cleaning
- Ease of repair

The coating material specified for the first roof support cylinders was martensitic stainless grade 431 (UNS-S43100). It was selected because of its combination of corrosion and wear resistant properties. For another mine, with high salt-bearing ground water and hydrogen sulphide gas present, the high nickel/molybdenum/chromium alloy 625 (UNS-N06625) has been specified.

Practical Applications

The laser has provided additional diversification opportunities for Jarvie Engineering. The quality of the coating and the broad range of materials that can be deposited has facilitated entry into the plastics, cotton, sugar and aluminium industries. The potential to develop and apply novel industrial laser processes including transformation hardening and surface alloying can provide

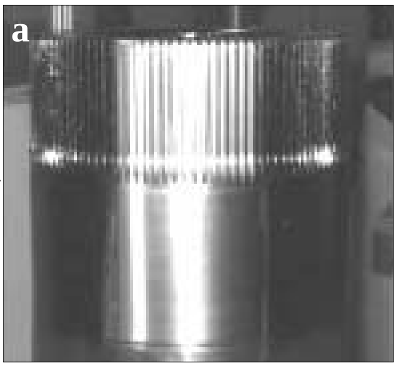

Figure 4. Some typical examples of laser cladding applications in Australia.

(a) Laser cladding of bearing and spline. Stub-axle drive splines and bearing surfaces are replaced by multi-pass laser deposition prior to machining and re-splining. The bearing surface was laser clad with 431 stainless steel and the spline was completely removed and laser clad with low alloy steel.

(b) Laser cladding of coal dump truck axle assembly. Large mining components similar to this single piece coal dump truck axle/differential assembly can be resurfaced and refitted in hours rather than weeks.

Figure 5 Laser cladding system

longer-term opportunities. Figures 3 and 4 present typical examples of laser cladding applications in Australia..

Jarvie Engineering has experienced a variety of challenges adapting to laser cladding, including researching laser and competing processes, meeting high establishment costs and generating market acceptance of the process. Once established, the challenge to understand the technology is ongoing. Major problems have included the training for key employees, understanding and providing for the needs of a laser system, and keeping the machines productive.

The two CO_2 laser systems seen in figure 5 were the first of this type to be commissioned in Australia. In hindsight, greater attention should have been paid to the ability of the system supplier to support and maintain the system components and provide process training. The system has a diagnostic control interface linked to the laser manufacturer, but some major technical problems nevertheless required specialist maintenance staff to travel from overseas. The service fee could exceed 10% of the initial capital cost of the laser! Spare parts and lost production amplify the running costs. Identifying manufacturers of other system components (motion system, powder feeder, 5th axis etc.) and acquiring spare parts took many months in some cases.

Conclusion

Jarvie Engineering has been operating two high power laser systems for over three years. The selection and application of an industrial laser cladding process has solved the customer's problem, set new standards for coating quality and provided new opportunities for the application of industrial coatings in Australia. The installation of a second laser cladding system at Jarvie Engineering is testimony to industry acceptance of the process. Laser cladding combines a wide variety of sciences and will continue to provide a series of technical and financial challenges.

This article is based on a paper given at the ICALEO Conference (Scottsdale, AZ 14 - 17 October 2002) and is published with the kind permission of the Laser Institute of America.

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Arc-assisted high power laser welding of steel

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Fabrication and welding industries are continuously striving to improve productivity, hense new improved welding technologies are regularly being evaluated. One area of development is to combine different welding processes to produce a welded joint exhibiting properties and productivity benefits that neither process could achieve individually. One promising combination is of arc and high power laser beam welding. If the arc and laser beam are kept separate but both contribute to completion of a joint, it is known as 'dual process' welding, whereas if both the laser beam and arc are combined in the same weld pool to complete a joint it is known as hybrid welding.

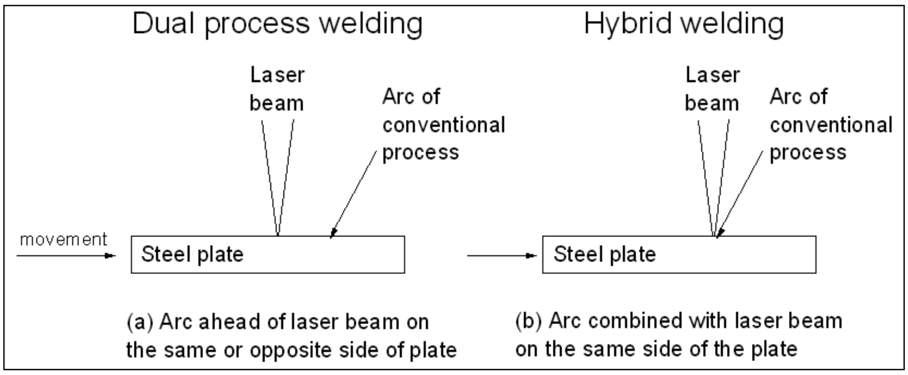


Figure 1. Comparison of 'dual process' and hybrid welding configurations involving arc and high power laser welding technologies

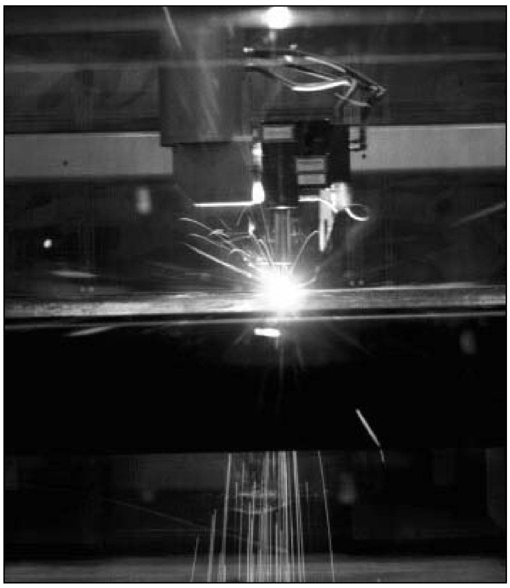
These two combination processes are currently being investigated by Corus RD&T at Swinden Technology Centre in Rotherham and 'Mithrae', the new name for a Corus business unit at Corus, CC&I, Scunthorpe works that has been set up to provide laser welding expertise to other Corus business units and their customers.

Laser welding

Compared to conventional arc welding, high power laser beam welding offers reduced distortion at higher productivity rates. However, high power laser technology is relatively expensive and good joint fit up is needed to achieve an acceptable weld, if the use of filler wire is to be avoided.

In dual process welding, a lower laser power achieves partial penetration of the welded joint and the joint is completed with an arc welding process. This has the potential advantage of lower laser costs, while maintaining or improving quality and productivity. Hybrid welding offers these same advantages plus a less demanding fit up tolerance, which is especially useful where good fit up cannot be guaranteed.

Figure 2. A typical prototype for the construction industry being laser welded



The laser welding capabilities of Corus include CO_2 and Nd:YAG lasers at powers in the 5 kW power range, and a 25 kW CO_2 laser, believed to be the highest power commercial laser in use in the UK. A typical prototype product being welded in the 25 kW facility is shown in Figure 2.

Experimental Programme

The aims of the recent Corus RD&T projects that have been investigating both dual and hybrid welding, have been to investigate the expected improvements in productivity, costs and structural integrity that are achievable when welding thicker section steel between 6 and 30 mm thick.

<u>Dual processing experiments</u>

There are two options for dual processing:

- Arc and laser beam on same side of joint (as shown in fig 1)
- Arc and laser beam on opposite sides of joint.

Both options were investigated, but only the second will be described here because of the greater potential benefits that it was observed to offer. For example, it gives the welding engineer the ability to trail the laser beam behind the arc, so that the laser beam can process an area of joint that has been preheated by the arc. This process, which will be referred to as 'simultaneous dual process' welding, slows the cooling rate of the laser weld and hence avoids the high hardness that can be a characteristic of this type of weld. Alternatively, discrete dual processing can be employed, in which the laser weld is produced after the arc weld reaches ambient temperature.

The form of arc welding used to carry out these experiments was the recently-introduced synchronised tandem wire arc welding

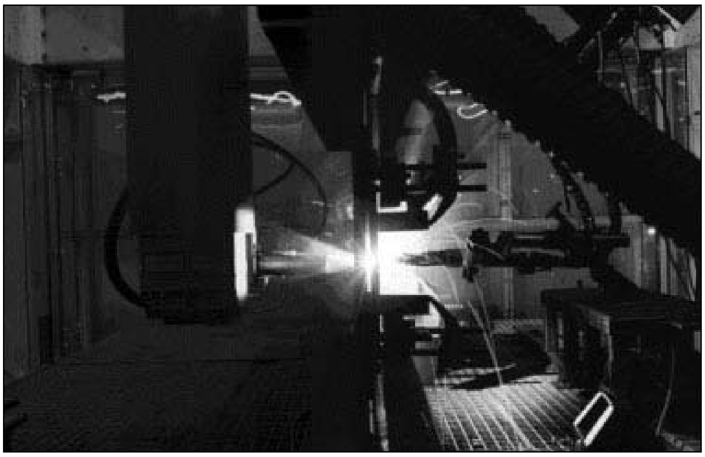


Figure 3. Dual process welding using the 25 kW CO_2 laser at Corus' Scunthorpe works. The laser head and the offset arc welding gun can be seen on the left and right of the photo respectively

process. This technique provided arc welding speeds compatible with those achieved with laser welding, and much higher than the speeds achievable with single wire arc welding systems. The optimum distance between the arc and laser beam were determined, after which welds were produced and examined.

An example of dual process welding is shown in figure 3 and examples of discrete and simultaneous dual process welds, produced with the laser beam in the horizontal position, are shown in Figure 4.

It can be seen that the use of arc preheat has enhanced laser weld penetration and broadened the weld bead shape, which suggests benefits for productivity and improved resistance to solidification cracking resistance, respectively.

Microhardness traverses along the arc, laser and mid point of both of these dual welds are shown in figure 5. The results clearly show that the use of preheat significantly decreases the hardness of the laser weld.

Dual process welding has been applied to steel plate up to 25 mm thick. Overall the work has shown that dual processing can give significant improvements in productivity compared to arc or laser welding alone. Capital costs of equipment, compared to laser welding only, are expected to be lower since dual processing allows a lower power laser to be used to complete joints. The observed reductions in weld hardness suggests additional benefits to the structural integrity of joints, and this is currently being investigated in more detail. The total heat input of this process is lower than it would be if arc welding alone were used to produce the joint and hence benefits to distortion control are expected. The main disadvantage of this welding technique was the need for good joint fit up. Where this cannot be guaranteed, it is suggested that hybrid welding be considered.

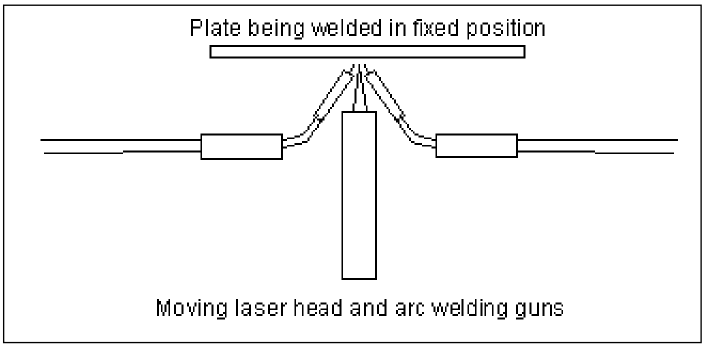


Figure 6 Hybrid welding set up

Hybrid welding experiments

Corus have assessed the combination of laser beam and arc into the same weld pool. Variables investigated include arc to laser beam separation, arc leading, laser leading and joint gap size.

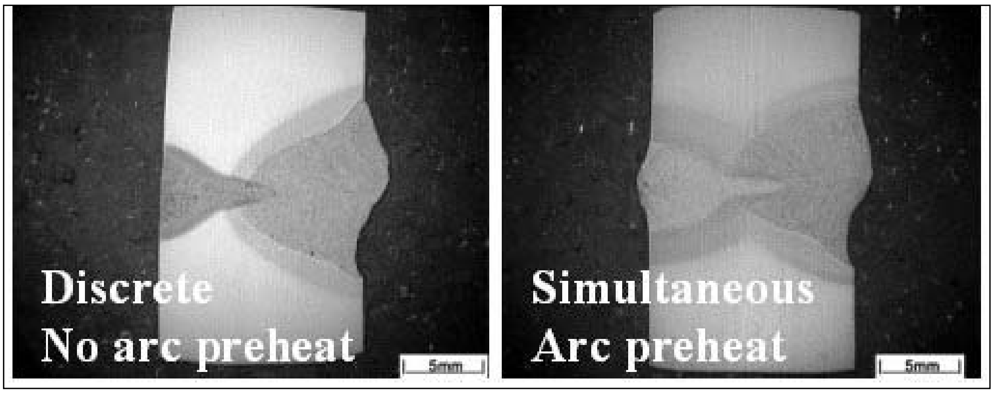


Figure 4 Sections of discrete and dual process welds in 13 mm thick grade X52 steel plate (laser weld left, arc weld right). The welds were produced at 1 m/min.

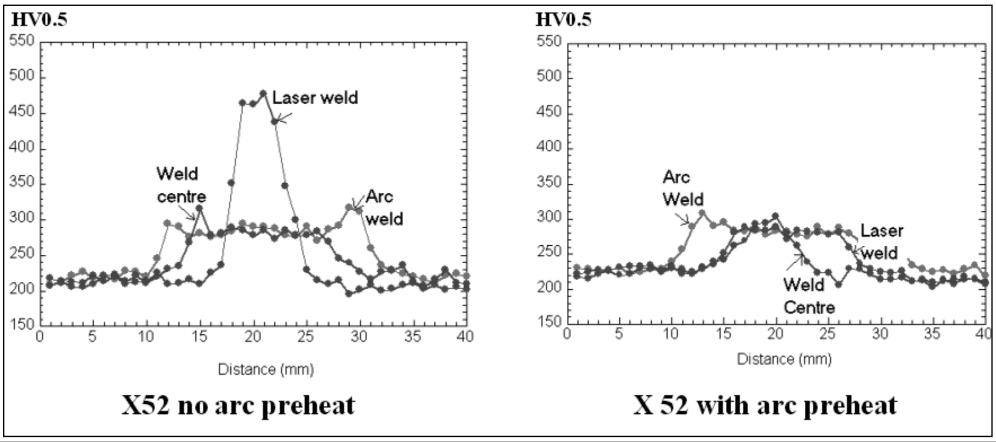


Figure 5 Microhardness values durin traverses along the arc, laser and mid point of both of the dual process welds shown in figure 4.

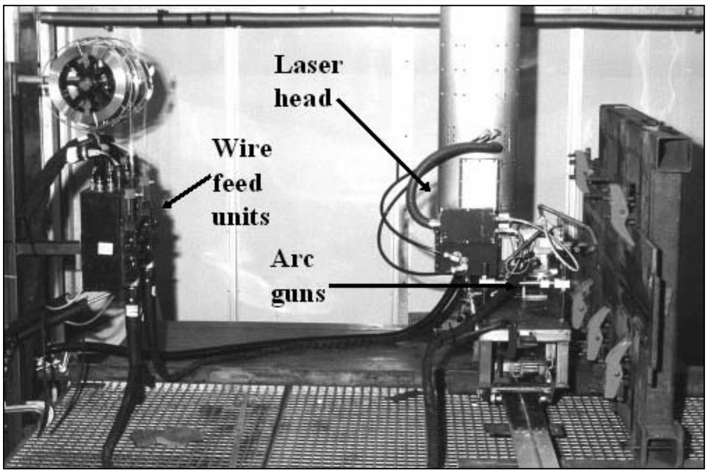


Figure 7. Experimental arrangment for hybrid welding equipment. Welding was carried out in the horizontal/vertical position to prevent gravity from promoting weld pool sagging and drop out.

Up to 19 mm thick steel has been hybrid welded using the 25 kW CO_2 laser. The set up, a schematic of which is shown in figure 6, employs two arc welding guns connected to two Metal Active Gas (MAG) power sources, traversing simultaneously with the laser head.

The hybrid welding equipment is shown in figure 7. A typical hybrid weld is shown in figure 8 and typical hardness results are shown in figure 9.

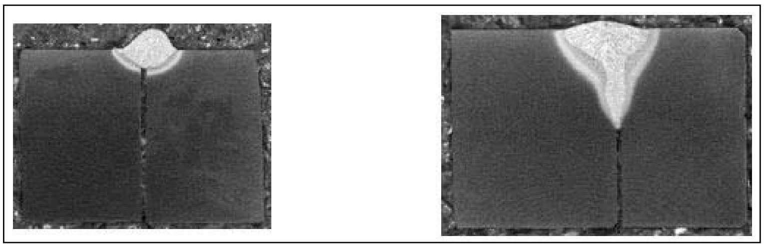


Figure 8. Comparison of arc and hybrid welds in 13 mm thick grade X52 steel plate , at 1 m/min travel speed and a 0.5 mm gap between plates.

Left: 200 amp arc weld
Right: The same arc weld trailing a 5 kW laser beam.

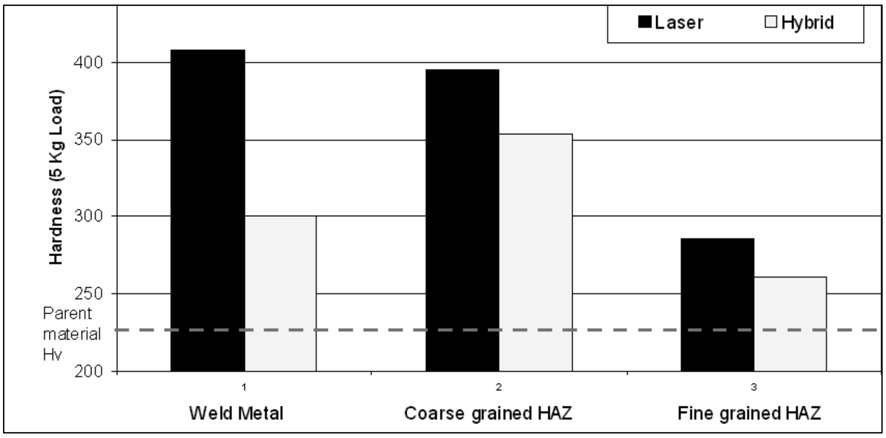


Figure 9 Comparison of hardness results for laser and hybrid welding

Hybrid welding provided tolerance to fit up gap, since it was not possible to laser weld with a 0.5 mm gap. The process also improved productivity as compared to that achieved using laser or arc welding alone. This was due to the penetration achieved, enhanced further in the presence of a fit up gap. Benefits to hardness have also been observed, with a generally lower hardness in hybrid welds than was found in purely laser welded joints, suggesting benefits to such properties as toughness. Similar benefits, such as tolerance to fit up and enhanced productivity, are being observed for aluminum welds, and this will be reported in a future article.

Conclusions

The benefits of dual and hybrid welding technologies have been demonstrated. Both processes have been observed to provide the potential for improvements in productivity and properties as compared to arc or laser welding alone and reduced costs compared to laser welding alone. It has also been observed that where it is not possible to guarantee good fit up, then hybrid welding should be considered in preference to dual process welding.

Corus will be quantifying the benefits of dual processing and hybrid welding in more details, so that welding engineers can make more informed decisions on process selection. The influence of the following parameters will be quantified in this ongoing study:

–Tolerance to fit up

–Speed/penetration

–Relationship between welding parameters and bead profile

–Distortion

–Structural integrity

Acknowledgments

The work detailed in this article was carried out by Corus RD&T. The author wishes to acknowledge the input of all RD&T staff associated with it, especially Dr Andrew Norman who has been working with the author to investigate hybrid welding and Douglas Stuart for his arc welding assistance. Thanks are also expressed to personnel at the Mithrae laser processing unit for assisting with production of welds, specifically Stuart Pigg, Norman Howden and Steve Ayre.

Clint Wildash is a Senior Technologist in Corus RD&T at Swinden Technology Centre in Rotherham. He has been with the company for over three years after obtaining his degree and PhD in materials engineering and welding technology respectively. His current project activities include laser and arc welding process development, materials weldability assessments and finite element modelling of welding.

The thin disk laser – a high precision welding tool

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Lasers have evolved to become important tools for industrial manufacturing technology, with high processing speed, quality, flexibility and low energy input the most important advantages of laser processing. At the present time CO_2 and Nd:YAG are the prevailing sources for laser material processing. Even if today's Nd:YAG-lasers are more expensive, have lower beam quality and lower efficiency than CO_2 lasers, they are being used for an increasing number of applications previously the domain of CO_2 lasers, cw-welding in particular. The main reason for this is their short wavelength and the fact that silica fibres can be used for beam transport. This allows high flexibility and accessibility, as well as lower costs for the beam delivery system. With regard to process considerations, the shorter wavelength of the Nd:YAG laser beam leads to higher absorptivity in metals and lower absorption in the laser produced plasma.

With all these advantages and driven by market needs and customer requirements, the latest solid state lasers developments aim to reduce their relative disadvantages (higher expense, lower beam quality and lower efficiency) compared to CO_2. The diode pumped thin disk laser is one of the rising stars of this new laser generation.

Diode pumped YAG-laser

Using high power diode lasers instead of lamps to pump the laser crystal leads to higher overall efficiency and higher beam quality at the same time. Due to the high optical / electrical power conversion (> 30%) of the diodes and the more selective excitation of the laser gain medium, the overall efficiency of the diode-pumped laser is much higher than the efficiency of a lamp pumped system. At the same time, the heat released in the laser crystal is lower so the temperature-dependent thermal lens effect is less pronounced yielding a higher beam quality. Another advantage of using diode lasers as pump source is that one can consider the use of other active ions in the YAG host e.g. ytterbium (Yb) in place of neodymium (Nd).

In the context of high power diode-pumped laser operation, the Yb:YAG gain medium offers a high optical-to-optical efficiency (up to 83%), the possibility of using high doping levels (25%) and an absorption spectrum that enables InGaAs diodes to be used for pumping. The long lifetime and the reliability of this diode-type leads to reduced running costs.

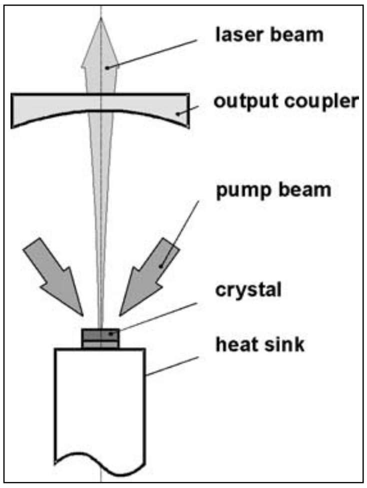


Figure 2:
Schematic setup of a thin disk laser

In the first generation of diode pumped solid state lasers (DPSSL) the geometry and the cooling technique of the crystal is almost the same as in lamp pumped devices, as shown in figure 1. However, it follows that with this geometry, although the thermal lensing effect will be reduced by virtue of the diode pumping, the effect cannot be eliminated.

The principle of a thin disk laser is shown in figure 2. The basic idea is to use a very thin laser crystal disk with one face mounted on a heat sink. As can be seen in the figure, the distance between heat source and heat sink is very short. This results in a very small and radially homogeneous temperature rise within the crystal, leading to a considerable reduction of thermal lensing when compared to circumferential cooling schemes. For this reason, a higher laser beam quality can be achieved.

A typical Yb:YAG crystal disk for this application has a diameter of 7 mm and thickness 0.3 mm. The resonator comprises the lower face of the laser crystal itself, which is HR-coated, and the output coupler. For optimal absorption of the pump light at a given thickness of the crystal, the pump light has to make multiple passes through the disk..

The laser wavelength of the Yb:YAG crystal is 1.03 µm. With a single thin disk one can achieve a laser output power above 500 W at a very high optical efficiency, which enables wall plug efficiencies of about 15%.

The first thin disk laser designed for material processing was presented by TRUMPF-Laser three years ago at LASER'99 in Munich. Since then, another four prototypes, each providing 1.5 kW laser output power, were installed at the IFSW in Stuttgart. With a beam quality of 6 mm.mrad, which is four times better than a conventional lamp pumped laser, optical fibres with core diameter of 150 µm can be used.

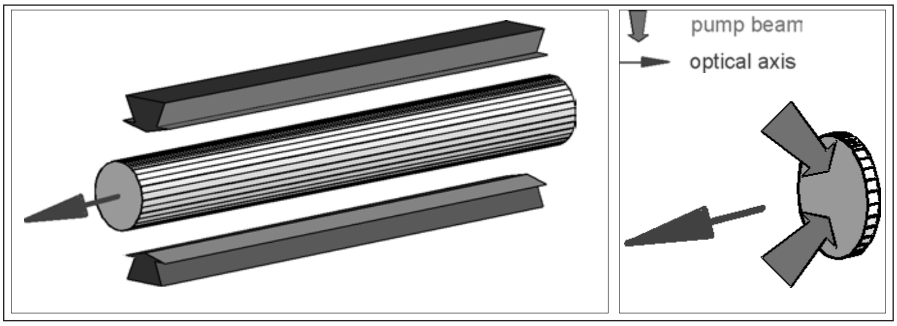


Figure 1:
Comparison of geometries for optical pumping of (left) a crystal rod and (right) a thin disk

Improved beam quality, which implies good focusability, is an important factor for laser welding. With the thin disk laser, one can achieve either a significant reduction of the focus diameter by using the same focal length optics or an increased working distance at the same focus diameter. As illustrated in figure 3 the higher beam quality of the thin disk laser allows a relatively slim, compact focusing head to be used. In this way, accessibility is improved, integration in the handling device is facilitated and the dynamics of the handling device are improved due to the smaller moving mass.

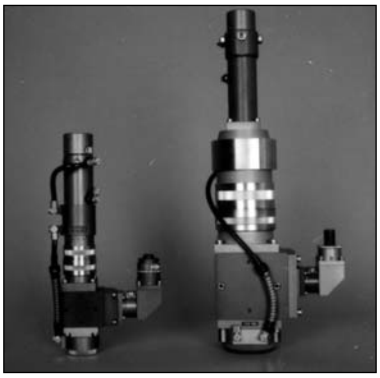


Figure 3: comparison of welding heads (left) for a thin disk Yb:YAG laser and (right) for a lamp pumped Nd:YAG laser of the same power. The reduced size of the welding head for the thin disk laser is a result of its high beam quality.

Welding of thin metal sheets

Figure 4 shows the welding depth for aluminium and steel as a function of the laser power for a range of focus diameters. The latter was varied by changing the focal length of the focusing optics and/or by using fibres of different core diameter. The results show that a higher beam quality, reflected in a smaller focus diameter, leads to an increase of the penetration depth.

For welding small components, for example, the required small welding depth is nearly impossible to achieve using a cw lamp pumped laser (i.e. either one can use heat conduction welding or, if keyhole welding starts, the penetration depth is too high)but a thin disk laser permits reliable cw-welding of thin metal sheets. For example, a reliable welding depth of 0.5 mm in aluminium can only be achieved with the thin disk laser source.

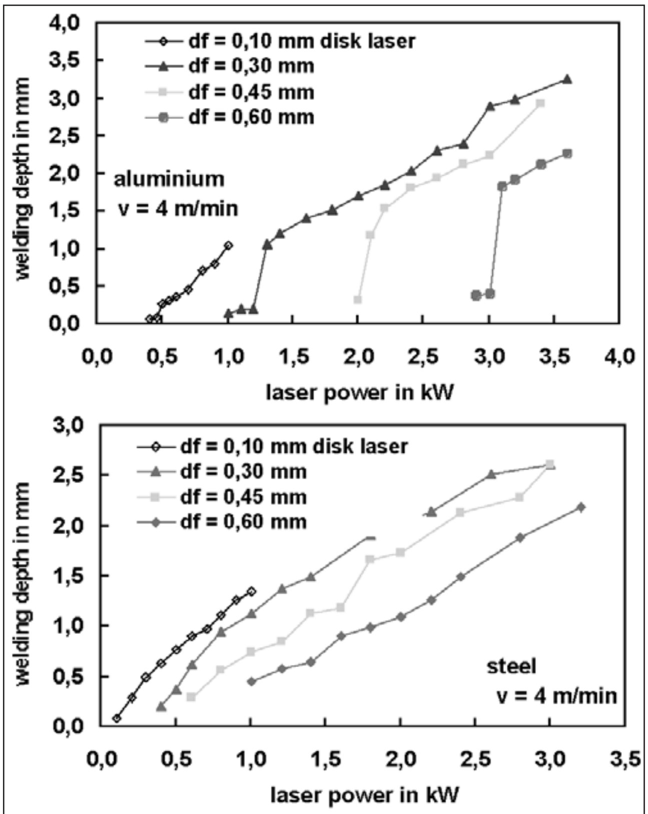
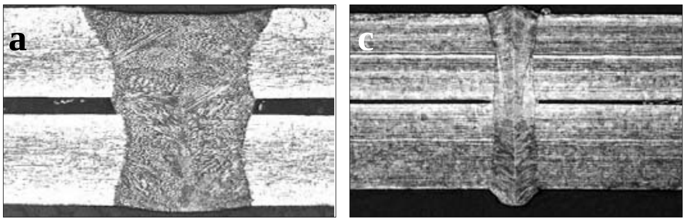


Figure 4: Welding depth for aluminium and steel as a function of the laser power.

The threshold between conduction limited welding and deep penetration welding, marked by the sudden increase of the welding depth, shifts to smaller power values for smaller focus diameters and is more pronounced in aluminium than in steel.

In the case of steel, a 0.5 mm welding depth can also be achieved with a focus diameter of 0.3 mm (Nd:YAG-Laser). Due to the higher laser power needed in this case, a safe and reliable process becomes much more difficult to realise since the resulting higher energy deposition in the workpiece produces increased distortion, possibly welding defects too. In this case the cw thin disk laser can be used in applications until now reserved for pulsed lasers. By welding in cw-mode a significantly higher speed can be achieved without compromising seam quality .

In figure 5(a) and (b), a cross section and the corresponding upper bead of an overlap joint in stainless steel are shown. The welding result reveal the absence of seam defects such as hot cracks, pores and holes. The upper bead is uniform and no undercut is observed. The deep penetration welding process even enables the bridging of gaps between the sheets. Figure 5(c) shows an overlap joint between two 0.5 mm thick stainless steel sheets, performed with the thin disk laser. The picture illustrates that welding seams with very high aspect ratio can be obtained by using laser sources with high beam quality.



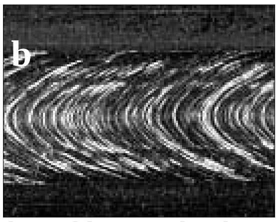


Figure 5. Welding overlap joints in stainless steel with a thin disk laser (a) Cross section and (b) upper bead, in 0.15 + 0.15 mm thick material (200 W, 3 m/min). (c) Cross section for 0.5 + 0.5 mm thick material (800 W, 10 m/min)

The welding results shown above were made with relatively low laser power. However, the laser used is capable of considerably higher power and correspondingly higher processing speeds. First results have demonstrated processing speeds of up to 50 m/min without any signs of humping or other defects.

For laser beam welding of many industrial thin-sheet structures, the maximum processing speed is limited by the kinematics of the handling device. The high beam quality of the thin disk laser offers the possibility of overcoming these limits, for example by using dynamic beam guiding devices such as scanner systems. In this area, the results described in this paper demonstrate the enormous potential of the thin disk lasers in the field of welding thin and ultra thin metal sheets.

COMMENT

Rofin has also been developing thin disk Yb:YAG lasers for some time. We have presently demonstrated 1kW output with a beam quality of 6mm mrad.

The author is right that 'conventional' lamp pumped cw Nd:YAG high power lasers will have a beam quality of around 25mm mrad. However, Rofin's high power Nd:YAG lasers are diode-pumped and have a beam quality of 12mm mrad, with outputs up to 4kW. This is existing, proven technology.

Andy May Rofin Baasel UK

IEC/TC76 holds its annual meeting in the UK

The 2002 annual meeting of the International Electrotechnical Commission Optical Radiation and Laser Equipment Safety Standards Committee IEC/TC76 was held during October at the splendid facilities of the National Radiological Protection Board (NRBP) headquarters at Chilton, Oxfordshire. Delegates from Australia, Austria, Canada, Germany, Italy, Japan, Korea, Switzerland, USA as well as the UK attended.

Courtesy of the National Radiological Protection Board

Members of the IEC/TC76 laser standards committee outside the training centre at NRPB

IEC/TC76 is a group of international committees that formulates the international standards for the safety of equipment incorporating lasers and light emitting diodes. The scope of the standards defines limits for human exposure to optical radiation (180 nm to 1 mm) from artificial sources.

Currently the TC76 committee has nine active working groups. Each considers a specific aspect of the laser safety, such as medical laser equipment, high power lasers, non-coherent sources, safety of diode emitters as well as development and maintenance of the basic standards.

Over recent years the need for standardisation worldwide has increased. Given this trend and the expectation that laser technology and laser applications will continue their rapid expansion, it is more than likely that the high current level of laser standards development will continue.

The main customers of laser standards developed by IEC/TC76 include manufacturers of laser products, users of laser products, third party conformance assessment certifiers and Health and Safety organisations, including Government Agencies. IEC/TC76 has National representatives from all these interested and affected parties. Some 20 countries participate in the work although only eight are really active. The standards are used at all national levels but in some cases the standards are modified to conform to local conditions.

The Committee is responsible for all aspects pertaining to human safety in the use of lasers. Thus TC76 works on developing standard covering the basic of safety with laser equipment and also the safe use of lasers in various fields of application e.g. medicine, optical communications, laser materials processing. The committee also deals with some aspects of radiation safety pertaining to the general public e.g. laser light shows and displays. Of considerable importance in this latter context is the potential for lasers to visually impair airline pilots, car drivers etc.

An important task is to develop and recommend measurement methods necessary for laser classification and assessment of exposure levels. The Committee also develops safety requirements for products that contain light emitting diodes (LEDS).

<u>Standard maintained or originated by IEC/TC76</u>
IEC 60825–1: Safety of laser products – Part 1 Equipment classification, requirements and user's guide.

IEC 60825-2: Safety of laser products – Part 2 Safety of optical fibre communications systems.

IEC 60825-3: Safety of laser products – Part 3 Guidance on laser displays and shows.

IEC 60825-4: Safety of laser products – Part 4 Laser guards.

IEC 60825-5: Safety of laser products – Part 5 Manufacturer's checklist for IEC 60825-1.

IEC 60825-6: Safety of laser products – Part 6 Safety of products with optical sources, exclusively used for visible information transmission to the human eye (including indicating LEDs).

IEC 60825-7: Safety of laser products – Part 7 Safety of products emitting "infrared" optical radiation, exclusively used for wireless "free air" data transmission and surveillance (NOHD<2.5m).

IEC 60825-8: Safety of laser products – Part 8 Guidelines for the safe use of medical laser equipment.

IEC 60825-9: Safety of laser products – Part 9 Compilation of maximum permissible exposure to incoherent optical radiation (Broadband source).

IEC 60825-10: Safety of laser products – Part 10 Laser safety application guidelines and explanatory notes.

IEC 61040: Power and energy measuring detectors, instruments and equipment for laser radiation.

IEC 60601-2-22: Medical electrical equipment – Part 2 Particular requirements for the safety of diagnostic and therapeutic laser equipment.

<u>Other draft standards under current development are:</u>
IEC 60825-12: Safety of laser products – Part 12 Safety of free space optical communication systems used for the transfer of information.

IEC 60825-13: Safety of laser products- Part 13 Measurements for classification of laser products.

IEC 60825-14: Safety of laser products – Part 14 User's guide.

Any concerns or questions concerning laser safety standards can be addressed to the AILU representatives on the TC/76 committee: Mike Barrett (mikeb@prolaser.co.uk), Mike Green (mike@ailu.org.uk) or Brooke Ward (brookeward @saqnet.co.uk).

Mike Barrett Pro Laser

Meetings

Modelling laser processes

On the 28 November 2002, as the final activity in the four year EC supported Thematic Network on laser welding in the Transport Industries - TRANSLAS, a workshop on modelling in laser processing was held at TWI. Speakers from the UK and Europe were given the brief of describing their models, not in terms of mathematics, but in terms of performance and comparison to experimental results. For the most part speakers adhered to this request and only two or three equations were seen during the whole day! This approach to presenting modelling worked very well and the range of subjects covered included laser welding, both conduction limited and keyhole, laser cutting, laser powder deposition and distortion prediction. My 'man of the match' was Stewart Williams, from BAE Systems, who presented results of models, of varying degrees of complexity (and run time), for conduction limited welding of aluminium and for laser drilling.

Myself and the other TRANSLAS partners had tried to publicise this event (by electronic means), to as wide an audience as possible. However, it was disappointing to note that only about 30 people attended the event. I have to say I feel rather sorry for those who did not attend, as I am sure they would have found the day very interesting.

Paul Hilton

September Laser Welding at TWI

Laser hybrid welding on a large scale. *(upper) Laser hybrid welding of pipelines (Courtesy TWI) and (lower) structure of a vessel in manufacture (Couresy Meyer Werft)*

Meeting break *(Below) Delegates enjoying the exhibition*

March 03

10 ILSC 03 (10 -13)
International Laser Safety Conference
Adam's Mark Hotel
Jacksonville, Florida, USA
Contact: Laser Institute of America
W: www.laserinstitute.org

AILU Open Workshop
Rapid Tooling by laser: a recipe for survival
Venue and date to be confirmed

April

9 AILU Members' Meeting
Annual meeting, with presentations, AGM and factory tour
Jaguar Cars
Castle Bromwich Plant, Birmingham
Contact: AILU (flyers not yet issued)

21 - 26 June Munich
Laser Fair 'Laser 2003 - World of Photonics'

World's largest laser exhibition (23 - 26) plus conferences:

CLEO Europe

WLT Conference: Lasers in Manufacturing
including
4th international symposium on
Laser Precision Microfabrication LPM 2003 (21 - 24)

From June 21st to 24th, the fourth international symposium "Laser Precision Microfabrication – LPM 2003" will take place in Munich, Germany. The symposium is part of the congress "Laser in Manufacturing" which is organized by the German Scientific Community of Laser Technology WLT.

LPM 2003 focuses on reporting and discussing progress in the field of lasers and their application in precision microfabrication. Research institutes and departments that are active in the development of laser-based microfabrication techniques, are encouraged to participate in this conference.

Invited papers as well as oral and poster contributions will be presented. The proceedings of the symposium will be published by SPIE.

CALL FOR ABSTRACTS and further information:
W: www.wlt.de/LPM2003
E:lpm2003@wlt.de

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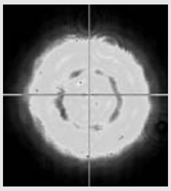

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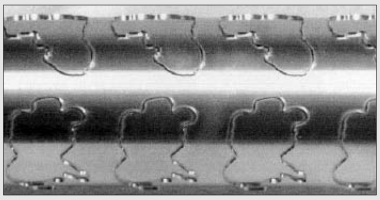

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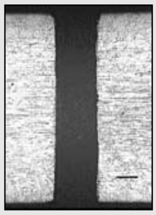

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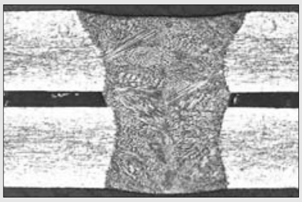

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Editorial Policy

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

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