HERIOT WATT UNIVERSITY

HERIOT-WATT UNIVERSITY

James Watt Institute - Innovative Manufacturing Research Centre

One Day Conference

Laser Based Production Processes

2012

EPSRC
Pioneering research and skills

IMRC
Innovative Manufacturing Research Centres

the association of
AILU
laser users

James Watt Institute *for* High Value Manufacturing

HERIOT WATT UNIVERSITY

1 DAY CONFERENCE

Laser Based Production Processes

26 June 2012 **Postgraduate Centre,** Heriot Watt University, Edinburgh EH14 4AS

08.30	REGISTRATION & COFFEE
09.00	*Welcome* **Prof Denis Hall** (HW-IMRC Director, Heriot Watt University, Edinburgh) **Professor Steve Chapman** (Principal and Vice Chancellor, Heriot Watt University, Edinburgh)
SESSION 1	**LASER JOINING**
09.10	**KEYNOTE I** *Innovations in laser welding and brazing using high brightness lasers* **Prof. Dr -Ing. Eckhard Beyer** (Executive Director Fraunhofer IWS, Dresden, Germany)
09.50	*Problems and solution in laser dissimilar welding* **Professor Stewart Williams** (Director, Welding Engineering and Laser Processing Centre, University of Cranfield, UK)
10.10	*An overview of laser Surfi-Sculpt development* **Dr Jon Blackburn** (Manager of the Laser and Sheet Process Section, TWI, UK)
10.30	*Application of laser and arc based hybrid process in pipeline welding* **Dr Supriyo Ganguly** (Lecturer, Welding Engineering and Laser Processing Centre, University of Cranfield)
10.50	COFFEE BREAK
SESSION 2	**PRECISION LASER PROCESSING**
11.10	**KEYNOTE II** *High power ultra short pulse laser processing - a new approach for high precision manufacturing* ***Dr.-Ing.* Arnold Gillner** (Department Manager Micro-Technology, Fraunhofer-Institut für Lasertechnik, Aachen, Germany)
11.50	*Micro-structuring of optical surfaces* **Professor Duncan Hand** (Director of Research & Deputy Head of School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh)
12.10	*Applications of high-performance OEM CW and pulsed fiber lasers in precision manufacturing processes* **Dr Paul Harrison**, (Principal Engineer, Product Applications SPI Lasers)
12.30	*Picosecond Laser Machining of Optical Fibre Based Cantilever Sensors* **Frank Albri**, (PhD Student, Heriot-Watt University)
12.50	**Poster 'Trailer' Session (1 minute per person)**
13.30	LUNCH AND POSTER SESSION + Demonstrations
SESSION 3	**LASER ADDITIVE MANUFACTURING**
14.30	**KEYNOTE III** *Computer-Aided Design for Additive Manufacturing: Can We Exploit Shape and Material Complexity Capabilities?* **Professor David Rosen** (Director of Rapid Prototyping & Manufacturing Institute, Georgia Institute of Technology, Atlanta, Georgia, US)
15.10	*Selective Laser Melting, Challenges for the Next 5 Years* **Dr Chris Sutcliffe** (Senior Lecturer, Centre for Materials and Structures, University of Liverpool, Liverpool)
15.30	*Additive Layer Manufacture for Healthcare Applications* **Professor Kenny Dalgarno** (Sir James Woodeson Professor of Manufacturing Engineering, *University of Newcastle)*
15.50	*Additive Manufacturing for Material Functional Grading of Components* **Dr Adam Clare** (Lecturer, Nottingham University)
16.10	COFFEE BREAK + WRAP UP AND NETWORKING

James Watt Institute *for* High Value Manufacturing

Laser Based Production Processes

POSTER SESSION

HERIOT WATT UNIVERSITY

P1 Sonia Andreia (Presenter); Martins Meco
Joining of steel to aluminium using laser welding-brazing
Welding Engineering and Laser Processing Centre, Cranfield University

P2 Usani Ofem (Presenter); Supriyo Ganguly; Stewart Williams
Laser Assisted Arc Welding Process for Deep Water Hyperbaric Application
Welding Engineering and Laser Processing Centre, Cranfield University

P3 Gonçalo Nuno Rodrigues Pardal (Presenter)
Welding of dissimilar metals
Welding Engineering and Laser Processing Centre, Cranfield University

P4 Ian Ashton (Presenter), Chris Sutcliffe
Analytical Modelling of Dynamic Focusing Optical Systems for Selective Laser Melting Applications
Centre for Materials and Structures, University of Liverpool

P5 Joseph Robinson (Presenter), Chris Sutcliffe, Peter Fox
Determining the effect of Scanning Strategy on the Residual Stress of Parts Manufactured using Selective Laser Melting
Centre for Materials and Structures, University of Liverpool

P6 Wenhe Feng
Dentin sample preparation for X-ray tomography using femtosecond laser pulses
Institute for Manufacturing, University of Cambridge

P7 Caroline Earl (Presenter) [1], Paul Hilton[2] and Bill O'Neill [1]
Laser Surfi-Sculpt®
1 - Centre for Industrial Photonics, University of Cambridge and 2- TWI Ltd.

P8 David Hopkinson (Presenter) and Andrew Cockburn
Fibre laser processing of nanocomposite Nd2Fe14B/Fe Magnets
Centre for Industrial Photonics, CDT Photonics Systems Engineering, University of Cambridge

P9 Chrisstel Ramirez (Presenter)
High Power femtosecond pulsed amplifier combining Ytterbium-doped materials in a MOPA configuration"
School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh.

P10 Krystian L Wlodarczyk (Presenter) and Duncan P Hand
Flexible shaping the surface of borosilicate glass with a liquid-crystal-based spatial light modulator.
School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh.

P11 Natalia Trela [1,2] (Presenter), Howard J Baker[2] and Denis R Hall [2]
High-Brightness, Ultra-Collimated Single Mode Emitter Arrays in a VHG-based External Cavity Configuration.
1-PowerPhotonic Ltd.
2- School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh.

P12 W.S. Góra[1] (Presenter), E.Harvey[2], B. Dhillon[3], A. McDonald[4], H.J. Baker[1], S Parson[2], D.P. Hand [1], J.D. Shephard[1]
Optimal processing parameters for laser machining of hard and soft biological tissue.
1- Institute of Photonics and Quantum Sciences, Heriot-Watt University, Edinburgh
2- Department of Human Anatomy, University of Edinburgh
3- Department of Ophthalmology, Edinburgh Royal Infirmary
4- Department of Conservative Dentistry, UCL Eastman Dental Institute, London

P13 Andrew Waddie (Presenter) and Mohammad Taghizadeh
Diffractive and Micro-Optics Design and Manufacture.
School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh.

P14 David Watson (Presenter) and Marc Desmulliez
Laser direct writing of metals onto plastic substrates.
Microsystems Engineering Centre, Heriot-Watt University,Edinburgh.

P15 Robert R J Maier[(1)] (Presenter), William N MacPherson[(1),] James S Barton[(1).]
M Cane[(2),] M Swan[(2),] J N Sharma[(2),] S K Futter [(2)] , D A Knox[(2)], B S Jones [(2)] and S McCullough[(2)]
Embedded Fibre Optic Sensors within Additive Layer Manufactured Components.
1. *School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh.*
2. *AWE Plc, Aldermaston.*

P16 Ian J Thomson (Presenter)[(1)] , Krystian L Wlodarczyk[(2)], Howard J Baker[(2)] , Denis R Hall[(2)]
Laser-machined, toroidal mode-selective mirrors for a high-brightness, unstable resonator Yb:YAG planar waveguide laser.
1- Selex Galileo
2- School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh.

P17 Vivien Beyer(Presenter), Wei Wang and Andrew Moore.
An investigation into the accuracy of optical vortex metrology.
Microsystems Engineering Centre, Heriot-Watt University, Edinburgh.
James Watt Institute and Heriot-Watt University.

P18 T Dinh Nguyen (Presenter), Jesus D Valera and Andrew J Moore
Thickness measurement using THz interferometry
James Watt Institute and Heriot-Watt University.

P19 Mickey Crozier (Presenter)
A novel series interconnect for thin-film PV
MSolv and Heriot-Watt University.

P20 Krste Pangovski (Presenter) and Bill O'Neill
Investigation of light-matter dynamics using ultrafast Digital Holography
Centre for Industrial Photonics, CDT Photonics Systems Engineering, University of Cambridge

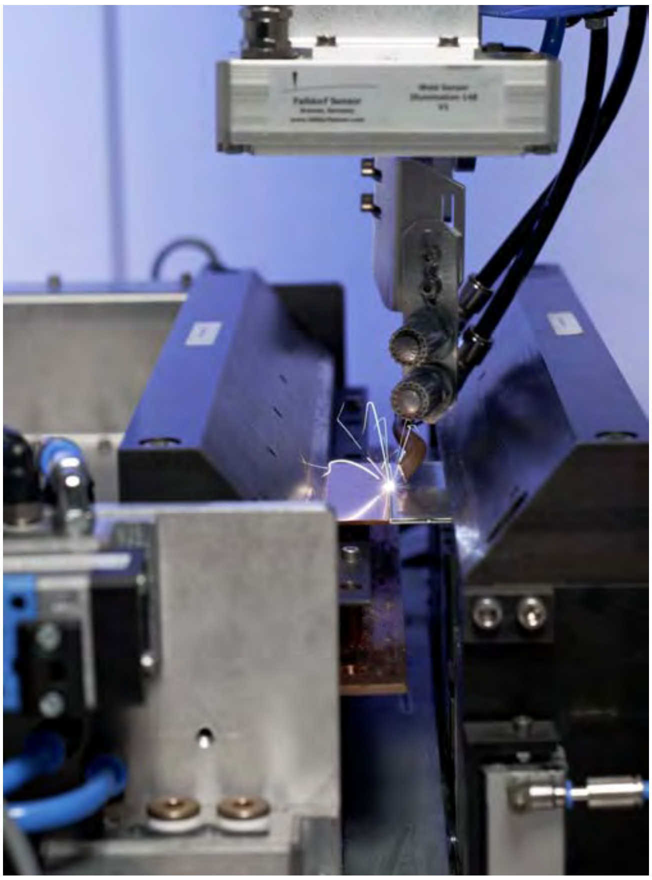
Innovations in laser welding and brazing using high brightness lasers

Prof. Dr -Ing. Eckhard Beyer
Executive Director Fraunhofer IWS, Dresden, Germany

Abstract:
In recent years, quality and reliability of high brightness lasers have been improved essentially. Therefore, welding and brazing with high brightness lasers can be called state of the art nowadays. In comparison to standard welding with fiber and disk lasers, welding with high brightness lasers opens new possibilities, as the keyhole can be specifically formed through the high-frequency oscillation of the beam. This influences the movement of the molten material and the creation of weld spatters. As seam width and depth can be specifically formed as well, welding of different materials as for example the combination of aluminium and copper can be facilitated.

A currently designed laser beam tool allows 2D spatial beam oscillations at 2 kHz with and even up to 5 kHz without simultaneous power modulation. The developed integrated laser welding system was already successfully applied in combination with a 2 kW single mode fibre laser for generating dissimilar metal joints such as aluminium - copper, stainless steel - copper and aluminium - magnesium. Those metal combinations are relevant for a multitude of practical applications.

The presentation will deal with laser welding with beam oscillation (up to 4 kHz), with joining of material combinations and with brazing.



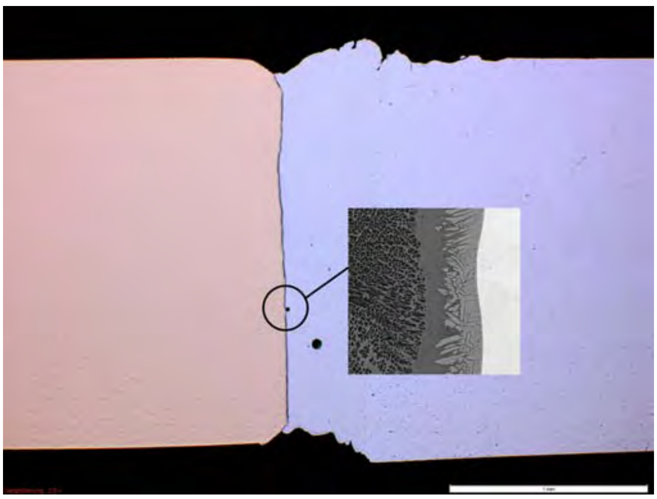
Short Biography

In January 1997, Eckhard Beyer assumed the position of Executive Director of the Fraunhofer Institute for Material and Beam Technology IWS in Dresden, which engages in application-oriented research and development in the area of laser and surface technology. The distinct feature of the Fraunhofer IWS is the exploration of alternative, customized processes, in addition to its proven laser beam techniques, leading to so-called hybrid processes.

Furthermore, E. Beyer was appointed to the position of full Professor for Laser and Surface Technology at the University of Technology Dresden in 1997. E. Beyer initiated the foundation of a new Institute of Surface and Manufacturing Technology in 2003, integrated his professorship and has been acting as the Director of this institute since that time. Since November 2009 E. Beyer has been Dean of the Faculty of Mechanical Engineering at the University of Technology Dresden.

Previously, E. Beyer was appointed Acting Director of the Fraunhofer Institute for Laser Technology in Aachen, where he started to work in 1985, later assuming the positions of Director of Laser Application and Deputy Director.

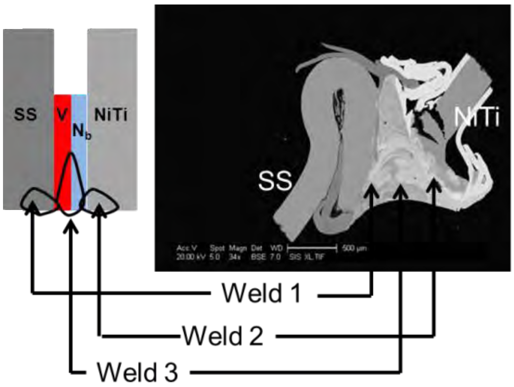
E. Beyer graduated from the University of Technology Darmstadt with a diploma in physics and received a Ph.D. in physical engineering. Before his studies in Darmstadt he studied engineering in Hamburg and worked subsequently as an engineer some years in industry.



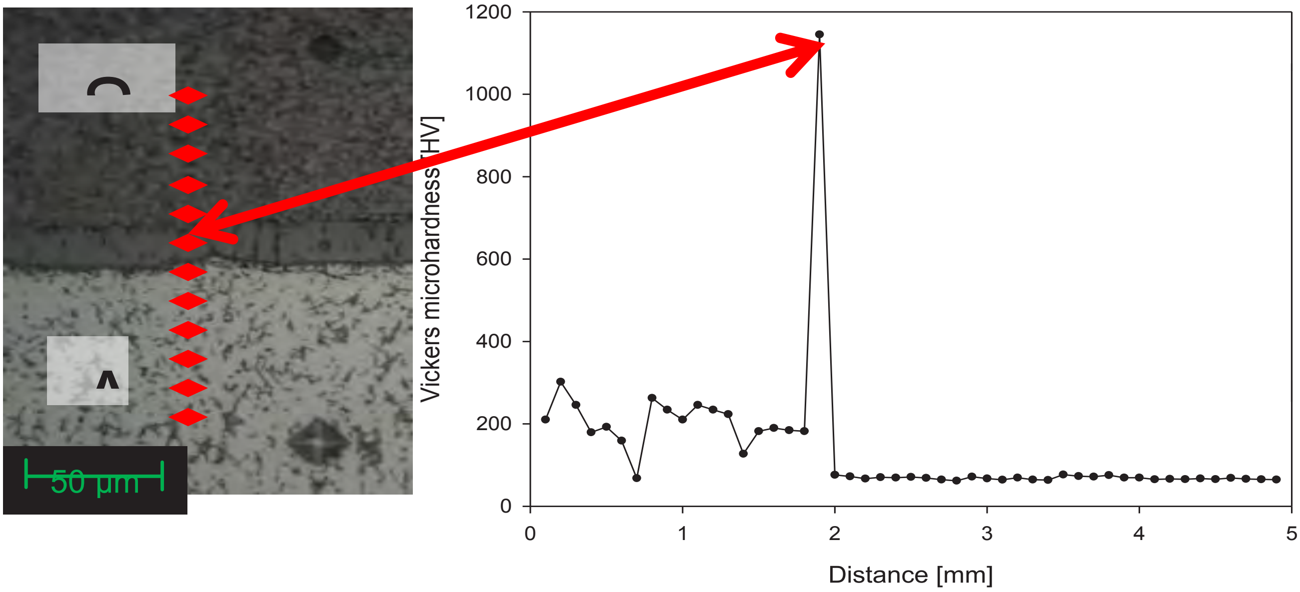
Problems and solution in laser dissimilar welding

Professor Stewart Williams
Director, Welding Engineering and Laser Processing Centre, University of Cranfield, UK

Abstract:
Joining of dissimilar materials is a major challenge with many inherent problems. Some of these are due to physical differences such as thermal and optical properties. Others are due to metallurgical differences such as lack of solubility from one material to another and the growth of brittle intermetallic layers. Lasers provide unique possibilities to solve these problems due to the ability to accurately and spatially control the exposure conditions. The use of this control will be demonstrated by the successful laser welding of steel to aluminium and Nitinol to stainless steel.



Extremely ductile weld metal. Failure occurred on the Nitinol parent metal side on complete reverse bending



Short Biography

Stewart Williams obtained his PhD in laser physics at London University Following his academic training Professor Williams spent five years at Edinburgh Instruments developing lasers and laser systems. In 1987 he moved to the Advanced Technology Centre of BAE Systems where he ran a group whose main area of research was laser processing of aerospace materials. This included welding, cutting, drilling, micromachining and surface treatments. Other areas of research were residual stress control in welding and direct write of functional materials. Currently he is Director of the Welding Engineering Research Centre (WERC) at Cranfield University. The main areas of research at the WERC are fibre laser processing, pipeline welding, additive manufacture, micro-welding, stress engineering and process modelling.

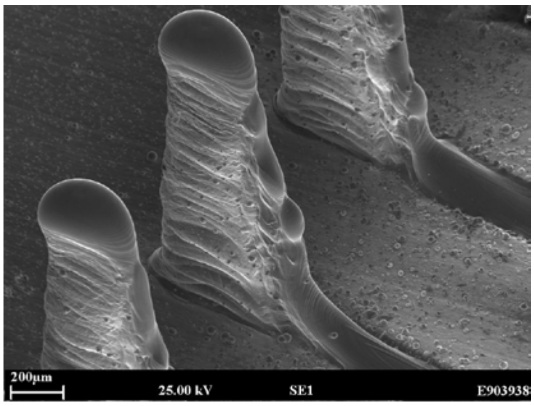
An overview of laser Surfi-Sculpt development

Dr Jon Blackburn
Manager of the Laser and Sheet Process Section,TWI, UK

Abstract:
Surface features may be used to enhance functional properties of materials, for instance; to enhance the biocompatibility of orthopaedic implants, to improve the thermal properties of heat exchangers, and to enhance the performance of composite to metal joints. The development of the Surfi-Sculpt® technique over recent years by TWI has resulted in a process capable of producing a wide variety of features in a range of substrates including, but not limited to, metals, polymers and ceramics. The Surfi-Sculpt technique is a non-additive process, which, through repeated and cyclic sweeping of a focused power beam in a predetermined pattern, induces material movement to 'grow' features from the bulk material. The technique was first demonstrated and developed using in-vacuum electron beams, but more recently using laser beams of 200-2000W in power. This presentation will review the development of the laser Surfi-Sculpt technique over the past five years, and discuss emerging applications.

Short Biography

Jon is the Manager of the Laser and Sheet Processes Section at TWI, where he has responsibility for leading and developing a team of Engineers who deliver projects to various industry sectors in the field of laser materials processing. He has experience in performing pre-competitive laser materials processing research, as well as delivering high value projects at higher Technology Readiness Levels. He has a MEng in Mechanical Engineer from Lancaster University and received his Doctorate in Manufacturing Engineering from The University of Manchester.



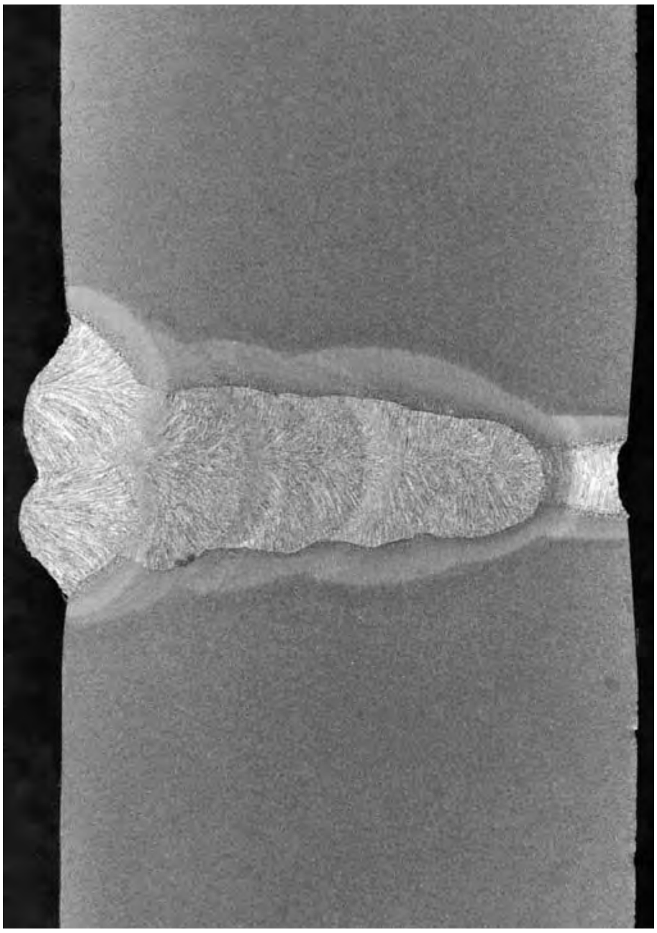
Application of laser and arc based hybrid process in pipeline welding

Dr Supriyo Ganguly
Lecturer, Welding Engineering and Laser Processing Centre, University of Cranfield, UK

Abstract:
The two main issues in welding of pipelines are the productivity and quality of the welded joints. How fast the root and hot pass is welded determines the productivity of the laying of a pipeline. The metallurgical characteristics of the weld metal and the strength of a welded joint depend on the use of appropriate filler wire which imparts the necessary solid solution strengthening. Laser welding, being a high power density process, is capable of very high penetration but adding filler wire in laser alone process is difficult. Gas Metal Arc Welding (GMAW) based processes are ideal for addition of filler wire. Also it gives high flexibility in joint set up as the heat source is relatively broader as compared to a laser spot. Therefore, laser and arc welding processes have the complementary characteristics which can make the laser and arc based hybrid welding an ideal tool to be exploited in pipeline welding. Research at Cranfield University is exploring the potential of applying laser and arc hybrid process to improve the pipeline welding productivity with improved metallurgical features of the welded joint.

Short Biography

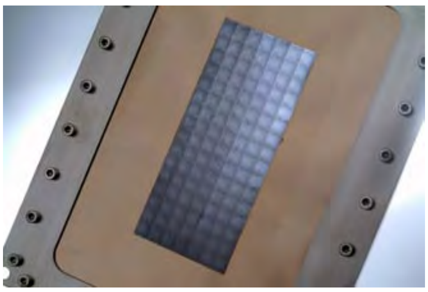
Dr Supriyo Ganguly is working as a lecturer in welding science at the Cranfield University since November 2008. Supriyo is a metallurgist and before joining at the Cranfield University he has worked in the Manchester University and The Open University as Research Fellow in different industry academy consortia. Supriyo has done his PhD in 1994 from the Open University on measuring and characterising three dimensional residual stress states in welded aluminium 2024 alloy for aerospace applications. Supriyo has worked for more than 7 years in Tata Steel, India. He was working as the Sr. Technologist, Long Product when he left in 2005. At Cranfield, his main research activities is focussed on welding of dissimilar alloys for structural and engineering applications and welding of pipeline for onshore and off-shore applications. He is now supervising 6 PhD students and the co-ordinator of three master course modules.



High power ultra short pulse laser processing - a new approach for high precision manufacturing

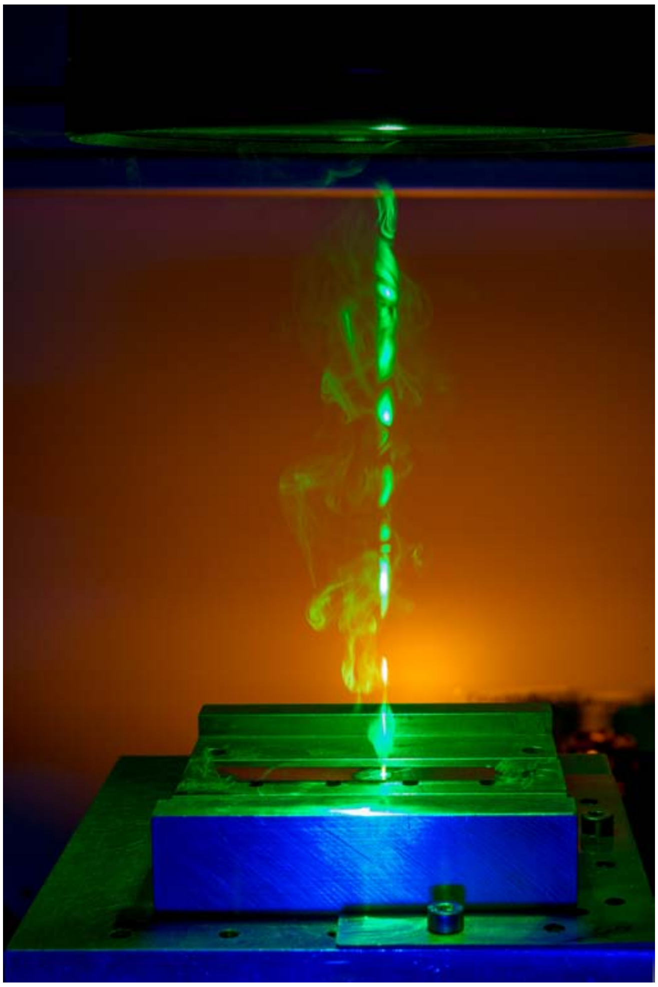
Dr.-Ing. Arnold Gillner
Department Manager Micro-Technology,
Fraunhofer-Institut für Lasertechnik, Aachen, Germany

Abstract:
Ultra-short pulse lasers present a new class within high-performance laser beam sources for industrial applications. Due to the outstanding features of the radiation emitted from these sources, which are addressing important physical principles of light-matter interaction, traditional processes of deposition of light energy into the material can be circumvented. With pulse durations in the picosecond and femtosecond range, the absorbed energy is concentrated in the material to a few nanometers, so that thermal damage to the materials can be avoided. Due to the high photon densities, the laws of classical absorption are suspended, so that virtually all materials can be processed independently of the wavelength used. Finally, ultrashort pulse lasers allow nonlinear modifications of materials, so that new material functions can be created. These properties provide new properties of precision machining at solar cells, batteries, injection molding tools and electronic components. Due to the current developments for power scaling of ultrafast lasers in the kilowatt range, also potential applications for macro processing are obtained, which opens large markets in other than the micro processing field. Thus, with high-power ultrafast lasers, fiber reinforced composites can be processed without thermal influence and large surfaces can be provides with friction-minimizing microstructures. Prerequisite for implementing this technology into industrial applications is a fundamentally new technology for scanning the laser beam with speeds of over 100 m/s to avoid overheating and use the fundamental properties of the new ultra short pulsed lasers.



Short Biography

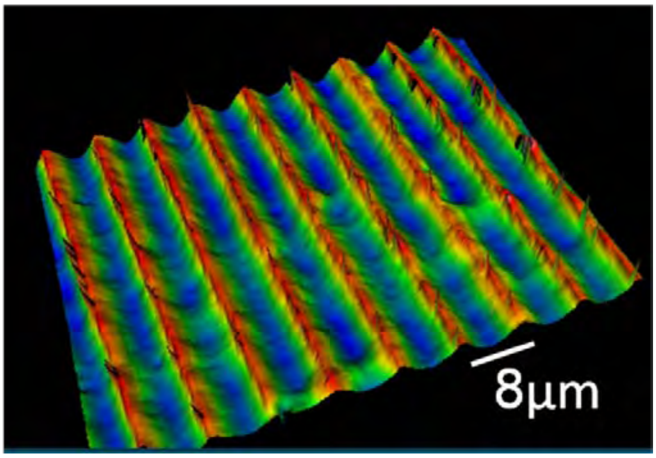
Dr. Arnold Gillner, studied Physics at the University of Darmstadt and made his PHD in Mechanical Engineering at the RWTH Aachen in 1994. Since 1985 he works as a scientist at the Fraunhofer-Institut for Laser Technology. Starting in 1992 he developed the department for Micro Technology at the ILT and from 2010 he is heading the department of Joining and Ablation. Together with more than 45 scientists he is developing industrial laser processes for macro and micro joining, packaging, micro and nano structuring, polymer applications and Life Science applications. He is member of the board of the Aachen Competence Center for Medical Technology and head of the advisory board of LifeTec Aachen Jülich.



Micro-structuring of optical surfaces

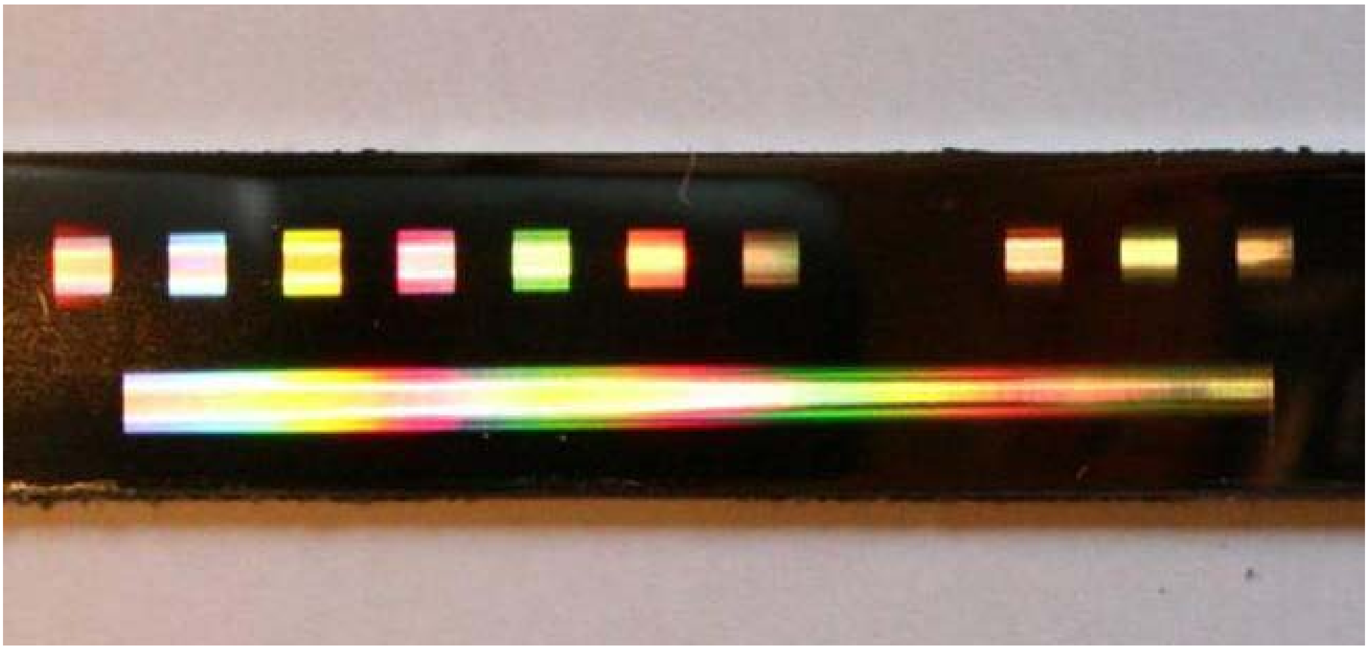
Professor Duncan Hand
Director of Research & Deputy Head of School of Engineering and Physical Sciences,
Heriot-Watt University, Edinburgh

Abstract:
The high precision achievable with laser processing offers the opportunity to manufacture bespoke optical elements. Laser machining in general has seen a move to shorter pulses (pico- and femto-second) to achieve the highest precision features. However, the ablation process driven by these ultrashort pulses results in optically rough surfaces which are highly scattering, and so such laser milling processes are unsuitable for the manufacture of optics. At Heriot-Watt, we have developed a range of processes using longer (millisecond) pulses of laser light, to provide a controlled melting process. Marangoni flow effects (driven by the dependence of surface tension on temperature) are exploited to provide highly localised surface structuring in order to generate the desired optical components. Examples of optical structures in both metals and glasses will be presented.



Short Biography

Duncan Hand has been a member of the academic staff at Heriot-Watt since 1997, and during this time has taken on a number of responsible roles including Director of the EngD Centre and Head of Physics, and he is currently Director of Research for the School of Engineering and Physical Sciences. His leads research focused on applications of high power lasers, in particular in manufacturing. This activity includes laser precision machining; the use of adaptive optics in laser manufacturing processes; and joining of dissimilar materials. In this work he collaborates with a range of companies including GE Aviation, Renishaw, BAE Systems and Selex. He has further research activity on the delivery of high peak power laser light through novel optical fibres (with applications in manufacturing and medicine), including a collaboration with the University of Bath on photonic bandgap fibres. He also has an interest in optical sensing, with current activity in optically-addressed fibre optic micro-cantilever sensors.



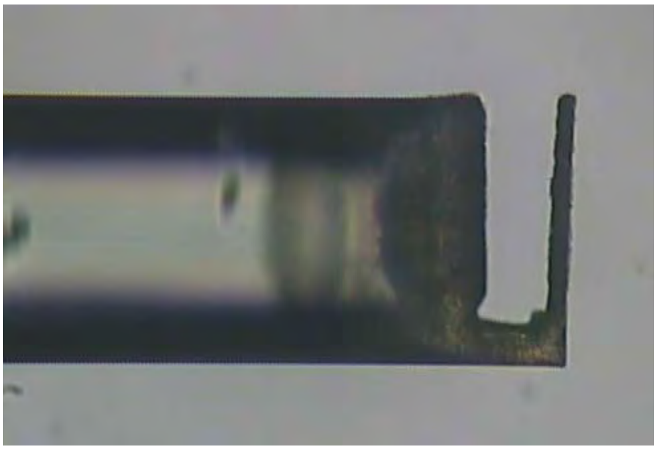
Picosecond Laser Machining of Optical Fibre Based Cantilever Sensors

Frank Alibri
PhD Student, Heriot-Watt University

Abstract:

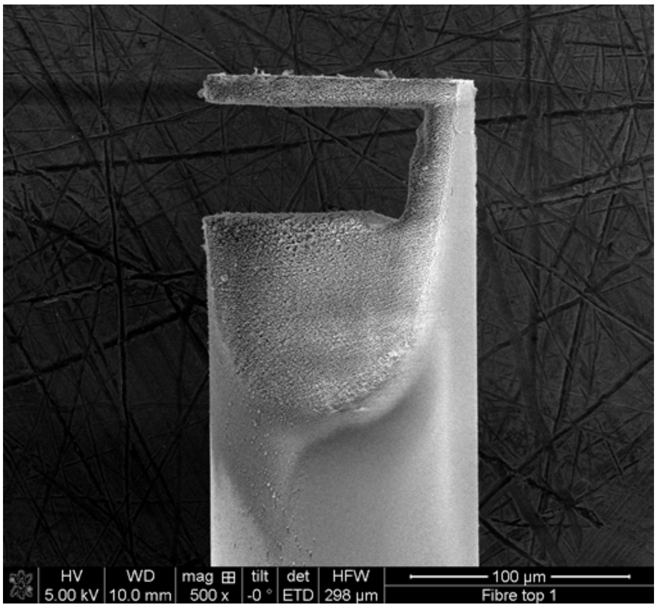
Ultrashort laser pulses (<10ps) enable machining of otherwise difficult-to-machine materials such as glasses and other transparent materials. We demonstrate an application of picosecond laser machining to manufacture cantilever sensor devices from fused silica optical fibres which are used widely in telecommunications technology and fibre optic sensing. A cantilever at the fibre tip forms an ideal sensing structure for several sensing applications including biomedical sensing. Whilst this can be achieved by focused ion beam machining, this is extremely slow (approx 4h per cantilever [1]). Ultrafast lasers provide an alternative and more efficient fabrication route.

We describe work using an industrial picosecond laser to ablate fused silica and thereby carve a cantilever out of a monolithic fused silica optical fibre. The applications of optical fibre sensors are widespread, and include strain or temperature sensing in addition to fibre-tip sensors. Cantilever based sensors are commonly used in atomic force microscopes, and they can also be used for biological sensing using appropriate activation coatings. Combining cantilever sensing with optical fibres has the advantage that (i) the cantilever and interrogation system are inherently aligned; (ii) sensing can be carried out in hazardous environments; and (iii) all electronics can be placed at a long distance to the probe. We demonstrate the feasibility of rapidly manufacturing fibre-end cantilever sensors using a single ps-laser manufacturing process, with a total machining time of less than 20 seconds. The performance of these cantilevers as sensing structures is also demonstrated.



Short Biography

Frank Albri studied Physics at University of Karlsruhe (Germany) from 2005 to 2008. In September 2008, he direct entered the 5th year of the MPhys course in Optoelectronics and Lasers at Heriot-Watt University and graduated in July 2009. He is currently studying for a PhD in "High-precision laser micro machining" within the Applied Optics and Photonics Research Group. The research concentrates on different time regimes used for micromachining from nanosecond pulse length towards femtosecond with an emphasis on the region of picosecond laser pulses. In his free time he enjoys cycling and photography.



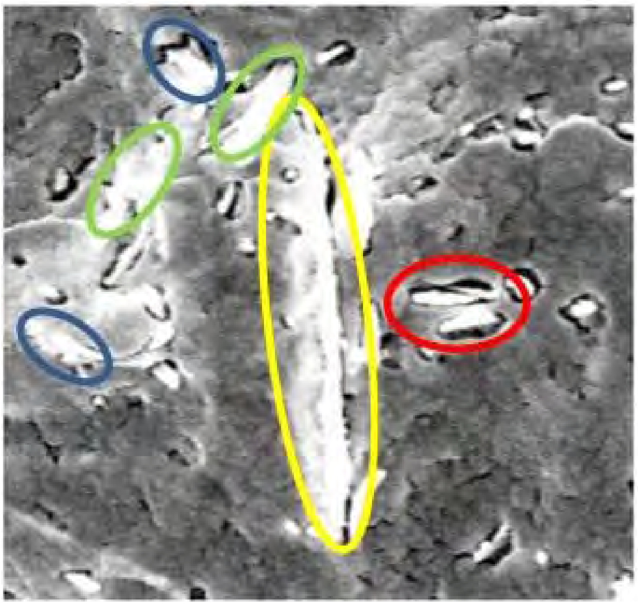
Computer-Aided Design for Additive Manufacturing: Can We Exploit Shape and Material Complexity Capabilities?

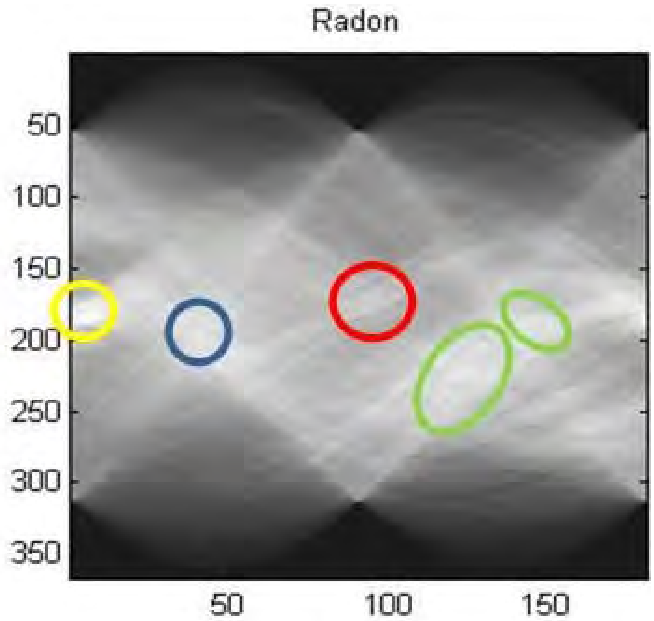
Professor David Rosen
Director of Rapid Prototyping & Manufacturing Institute,
Georgia Institute of Technology, Atlanta, Georgia, US

Abstract:
Additive Manufacturing (AM) technologies enable the fabrication of parts and devices that are geometrically complex, have graded material compositions, and can be customized. To take advantage of these capabilities, Computer-Aided Design systems must be able to represent thousands of geometric elements and understand how materials behave, which current CAD systems based on parametric, solid modeling approaches can not accomplish. We present new CAD technologies to achieve these objectives. For complex geometries, a new representation has been developed and demonstrated on a wide range of cellular materials (lattices, honeycombs, etc.). This representation has been used as the basis for a very efficient optimization method for designing lightweight structures. For understanding materials, an approach for integrating material process-structure-property relationships into CAD models has been developed. The approach is to use a common set of basis functions for representing both macro-scale part geometry and the micro-scale geometry of material microstructures, such as grains and fiber or particle reinforcements. Surfacelets (extensions of wavelets) are the basis functions that are used to construct a multi-scale, heterogeneous geometric/material representation. Advances in both areas are illustrated with examples of aerospace parts and materials.

Short Biography

David Rosen is a Professor and Associate Chair for Administration in the School of Mechanical Engineering at the Georgia Institute of Technology. He is Director of the Rapid Prototyping & Manufacturing Institute at Georgia Tech. He received his Ph.D. at the University of Massachusetts in 1992 in mechanical engineering. His research interests include computer-aided design, additive manufacturing, and design methodology. He has industry experience, working as a software engineer at Computervision Corp. and a Visiting Research Scientist at Ford Research Laboratories. He is a Fellow of ASME and has served on the ASME Computers and Information in Engineering Division Executive Committee.





Applications of high-performance OEM CW and pulsed fiber lasers in precision manufacturing processes

Dr Paul Harrison
Principal Engineer, Product Applications, SPI Lasers

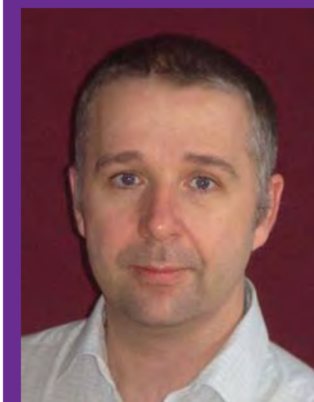
Abstract:
Low, medium and high power fiber lasers operating in the 1 μm region have proven capabilities in many industrial applications including cutting, welding and surface processing. This presentation reviews the capabilities of low power (up to 70W) pulsed fiber lasers for surface processing applications and medium power (up to 500W) CW-M lasers for cutting and welding. Critical laser and process parameters such as the temporal pulse shape are considered in order to examine how these can be used to produce a range of effects on the workpiece.

Short Biography

Paul Harrison graduated from Brunel University in 1992 with a degree in Electrical and Electronics Engineering and from Heriot Watt University in 2012 with an Engineering Doctorate in pulsed laser processing. From 2001 to 2009 he was the Applications Engineering Manager at Powerlase Ltd and in 2010 joined SPI Lasers as Principal Engineer, Product Applications.

Selective Laser Melting, Challenges for the Next 5 Years

Dr Chris Sutcliffe
Senior Lecturer, Centre for Materials and Structures, University of Liverpool, Liverpool



Abstract:
Selective Laser Melting (SLM) is now a widely accepted process for the manufacture of metallic components. In general the industries that SLM serves have specific specialized needs that cannot be met by other manufacturing routes. The SLM parts currently deployed tend to be very impressive being in the main complex muti-functional components with free form hierarchal designs which at first sight seem impossible to manufacture. The problem is of course that these "impossible" geometries do not represent the mainstream requirements of manufacturing industries. Our problem therefore is to move SLM from its position as a provider of small numbers of rare components to a supplier of large numbers of common components. This presentation gives an overview of where we are and where we might be in the next 5 years indicating some of the hurdles that will be encountered along the way.

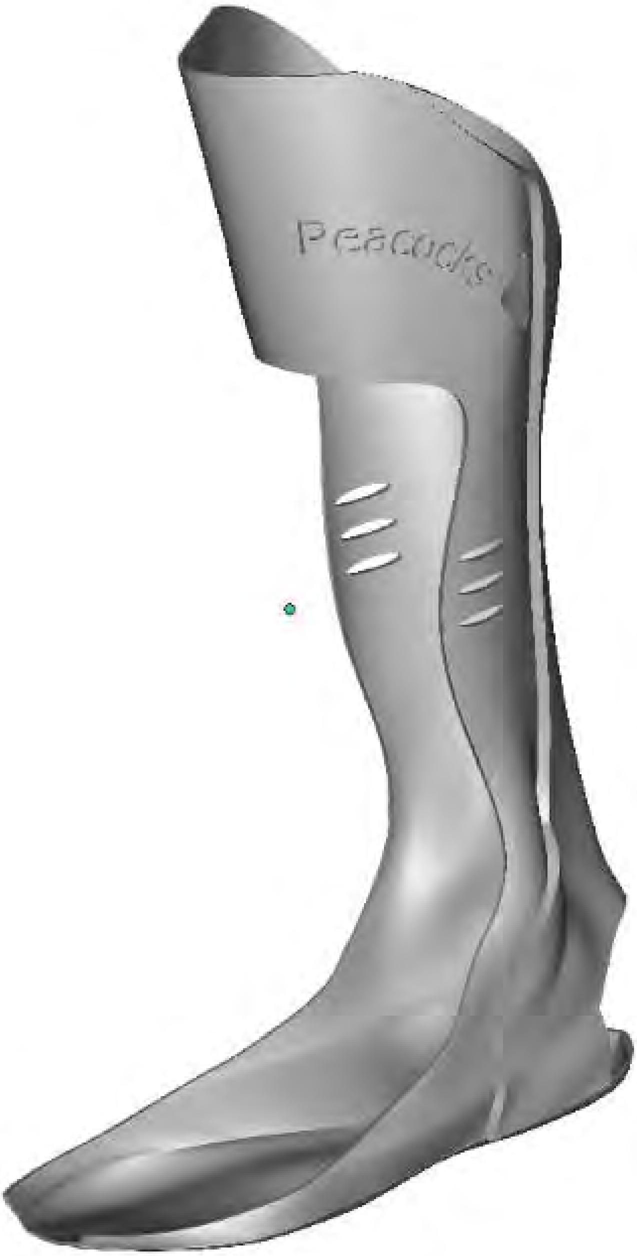
Short Biography

Chris Sutcliffe is a Senior Lecturer at the University of Liverpool School of Engineering where he develops novel manufacturing processes using additive manufacturing techniques. Over his 15 years in the additive manufacturing field Dr Sutcliffe has developed several manufacturing methodologies including Selective Laser Melting, Spiral Growth Manufacturing and various inkjet techniques. He has also pioneered the development of porous orthopaedic implants with international industrial collaborators. He has a PhD in Fluid Dynamics from the University of Liverpool and holds a position as R&D Director at Renishaw AMPD where he led the team that developed the UK's first commercial Selective Laser Melting Machine.

Additive Layer Manufacture for Healthcare Applications

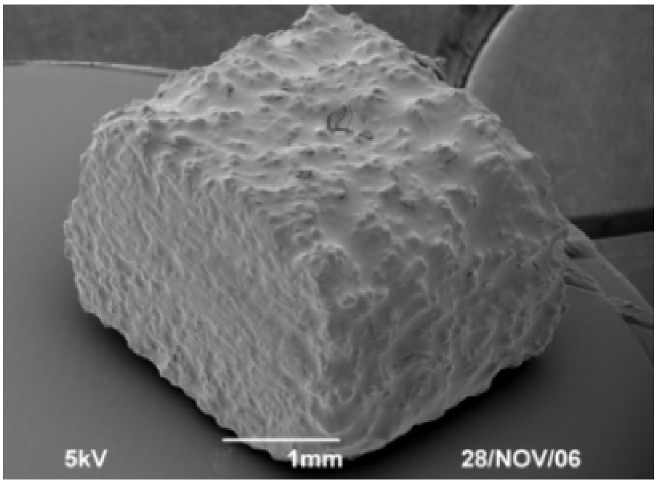
Professor Kenny Dalgarno
Sir James Woodeson Professor of Manufacturing Engineering, University of Newcastle

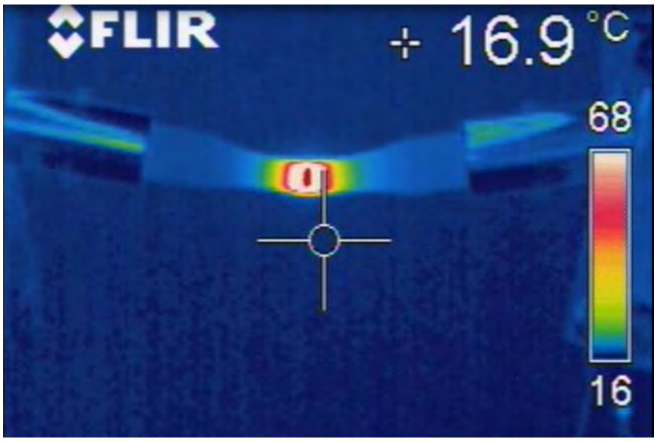
Abstract:
The ability of additive layer manufacture processes to deliver personalised devices has seen the processes exploited in a range of healthcare applications. This presentation will describe ongoing research into two particular applications: orthoses and regenerative medicine. The presentation will outline how additive layer manufacture can allow for optimal combinations of materials, geometry and structural properties to provide new opportunities in product development.



Short Biography

Kenny Dalgarno is the Sir James Woodeson Professor of Manufacturing Engineering within the School of Mechanical and Systems Engineering at Newcastle University. He has been researching additive layer manufacture for over a decade, with an increasing emphasis on their use in biofabrication in recent years. He is Deputy Director of the Arthritis Research UK Tissue Engineering Centre, and co-ordinator of the EC FP7 project RESTORATION (Resorbable Ceramic Biocomposites for Orthopaedic and Maxillofacial Applications)..

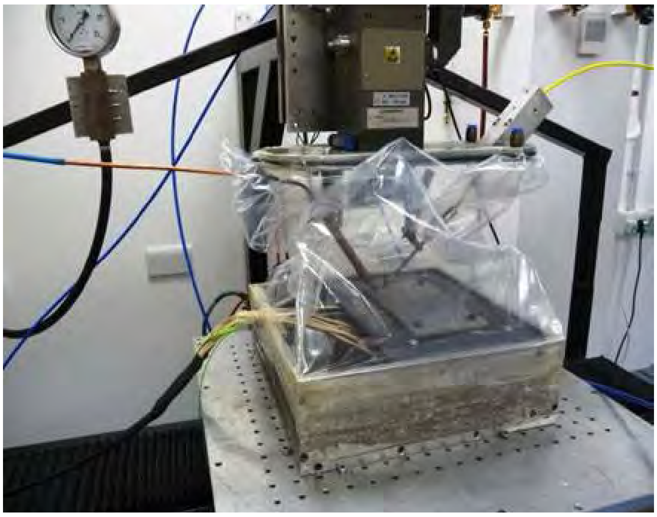


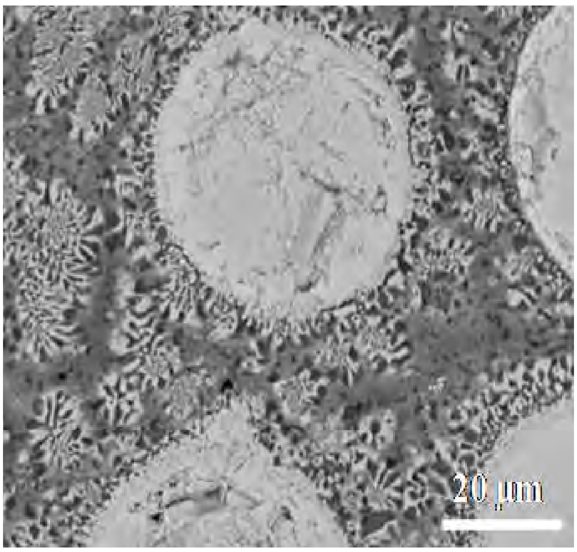


Additive Manufacturing for Material Functional Grading of Components

Dr Adam Clare
Lecturer, Nottingham University

Abstract:
Additive manufacturing presents a range of design freedoms which are not available through more conventional routes to net shape. One such freedom, through co-fed wire and powder laser deposition, is the ability to create functionally graded components. These may be engineered by modifying deposition parameters and feedstock blends, in process, to exhibit distinct material properties which may be graded throughout the structure. This allows normally mutually exclusive bulk material properties to coexist in the same component. This presentation will focus on the creation of metal matrix ceramics, the techniques used to optimise them and opportunities for the high value manufacturers who may exploit this technology.





Short Biography

I joined the University of Nottingham and the Precision Manufacturing Centre in 2010 after completing both my PhD and post doctoral research at the University of Liverpool. My research focuses on the use of non-traditional manufacturing methods to arrive at net shape while inducing novel or favourable material properties. My work has most relevance to the high value sectors which include the aerospace and biomedical industries.

My core competencies include: Electrical Discharge Machining (EDM) - Material effects and condition monitoring;
Electron Beam Melting (EBM) - Processing of aerospace, tool and biomedical materials; process modelling and understanding resulting material properties; laser processing of materials and Additive Manufacturing Techniques - Laser, powder, wire and polymer based techniques.

I am engaged in active collaborations with researchers in Europe, the USA and Japan where I have recently spent time as an invited fellow at the University of Tokyo.