Lectures at University of Bayreuth

Date: 22 March 2018
Place: University of Bayreuth, Faculty of Engineering Science, Universitätsstr. 30, 95447 Bayreuth, Germany

- PROGRAMME -

- 22 March 2018 -

09:30 – 09:45 Registration and Coffee

09:45 – 10:00 **Welcome. Introduction**
Dieter BRÜGGEMANN, Prof. Dr. University of Bayreuth, Bayreuth, Germany

10:00 – 11:00 **Fundamentals of Laser Systems for Laser Ignition. Passively Q-switched Nd:YAG/Cr^{4+}:YAG Lasers for Ignition in Automotive Engines**
Nicolaie PAVEL, Dr. INFLPR, Bucharest, Romania

11:00 – 11:15 Coffee break

11:15 – 12:15 **Laser Ignition in Aeronautical Applications**
Laurent ZIMMER, Prof. Dr. CNRS, Paris, France

12:15 – 13:15 Lunch (on site)

13:15 – 14:15 **Laser Ignition in Car Engines**
Geoffrey DEARDEN, Prof. Dr. University of Liverpool, Liverpool, UK

14:15 – 15:15 **High Temperature Suitable Bonding Technologies for Miniaturized Opto-mechanical Systems - Semiconductors, Crystals, Fused Silica, Ceramics and Metals Integrated in One Package**
Erik BECKERT, Dr. Fraunhofer IOF, Jena, Germany

15:15– 15:30 Coffee break

15:30 – 16:30 **Laboratory Tour**

- END OF LECTURES -

19:00 Dinner

- SPEAKERS -

Dr. Nicolaie PAVEL
National Institute for Laser, Plasma and Radiation
Laboratory of Solid-State Quantum Electronics
409 Atomistilor Street, Magurele 077125, Ilfov
ROMANIA
Email: nicolaie.pavel@inflpr.ro

Short biography

Nicolaie PAVEL is a senior researcher at National Institute for Laser, Plasma and Radiation Physics, Magurele, Romania. He graduated in July 1990 from Faculty of Physics, University of Bucharest and he received in 1997 a PhD in Physics from Institute of Atomic Physics, Bucharest. In 2013 he obtained his Dr. habil. title in Physics. His main interest is in the field of diode-pumped solid-state lasers and some laser applications (including laser ignition).

Fundamentals of Laser Systems for Laser Ignition. Passively Q-switched Nd:YAG/Cr^{4+}:YAG Lasers for Ignition in Automotive Engines

A passively Q-switched monolithic Nd:YAG/Cr^{4+}:YAG composite laser that is positioned directly on the engine cylinder is, to date, the best solution for ignition by laser of a car engine. However, realization of such a device with pulse performances suitable for ignition but also capable to operate in adverse conditions, similar to those of the engine, is challenging. In this talk the general theory of a solid-state laser (in particular Nd:YAG) that is passively Q-switched by a medium with saturable absorber (SA) properties (in particular Cr^{4+}:YAG) will be introduced. Operation at the fundamental wavelength, but also in regime of frequency doubling with a nonlinear crystal positioned intracavity, will be discussed. Results regarding stabilization of the emission wavelength of a Nd:YAG-Cr^{4+}:YAG SA laser with a Volume Bragg Grating and the influence of temperature on the laser pulse performances will be presented. In the end of this talk several laser spark plugs developed for ignition, by different research groups, will be introduced. Own data regarding operation of a 4-cylinder automobile engine that was ignited by laser spark plugs will be given shortly.

Prof. Laurent Zimmer
Centre National De La Recherche Scientifique
Laboratoire EM2C
Grande Voie des Vignes, Châtenay-Malabry 92295
France
Email: laurent.zimmer@centralesupelec.fr

Short biography

After completing his PhD in the von Karman Institute (BELGIUM), Laurent ZIMMER was a research fellow at the Japan Aerospace Exploration Agency for 6 years. Since 2007, he is a CNRS researcher in CentraleSupélec. His main research topics are development of measurement techniques to plasma and spray applications as well as post-processing methods to infer fluid mechanics dynamics from measurements or numerical simulations. His application field covers both aeronautical applications as well as land-based power stations.

Laser Ignition in Aeronautical Applications

Ignition of sprays remains an important issue for aeronautical applications. The final faith of an attempt strongly depends on local conditions (positions and sizes of droplets as well as velocities). It is therefore important to develop measurement techniques able to describe plasma properties as well as spray features. In this talk, two specific techniques will be described. A 2D-Laser Induced Plasma Spectroscopy will be presented, showing the feasibility as well as constraints of single shot measurements within laser-induced plasma. A second technique, aiming at measuring the time-resolved 3D dynamics of sprays will be discussed and its current limitations shown. Typical applications of those measurement techniques in Laser Induced Spray Ignition will be described.

Prof. Geoffrey Dearden
University of Liverpool
School of Engineering
Brownlow Hill L69 3GH, Liverpool L69 7ZX
United Kingdom
Email: g.dearden@liverpool.ac.uk

Short biography

Geoff DEARDEN is Professor of Laser Engineering at the University of Liverpool and has led the long-established research group there since 2012. He has more than 30 years' academic and industrial experience in laser engineering / photonics R&D, including previous employment with BAE Systems. His research interests include the experimental study of laser-material interactions and the application of laser techniques in manufacturing processes, laser ignition of car engines, sensing and optical manipulation. In addition to research and teaching, he has carried out knowledge exchange and training activity in laser technology since 1995, in support of SMEs in regional and European industry. He has over 180 scientific publications including 80+ journal papers and 4 patents awarded / published. He has supervised more than 35 PhD students and 300+ Masters' students. He has worked with well over 100 external collaborators and organisations worldwide including academic institutes, research organisations and industry partners large and small. He has served as Visiting Professor at 2 China institutes, as journal co-editor and as scientific advisor to conferences.

Laser Ignition in Car Engines

Ever since the discovery of laser induced spark breakdown, the possibility of laser-ignited car engines has drawn much interest in research. Compared to conventional electric spark ignition, laser ignition offers the potential (in principle) for depositing laser sparks with variable location and timing, with a more intense plasma for the same pulse energy and eliminating the problems of plug electrode protrusion into the combustion volume and the fouling / erosion due to this. With an emphasis on work carried out at the University of Liverpool, this lecture explores the laser beam engineering techniques investigated to realise successful laser ignition of commercial test car engines. In particular, both multi-location and dual pulse laser ignition of a single-cylinder engine were recently demonstrated, giving improved engine performance. These findings are deemed important for stimulating new research in laser ignition of engines, which is anticipated to extend to new applications in a broader range of engine types, not limited to automotive.

Dr. Erik Beckert
Fraunhofer Institute for Applied Optics and Precision Engineering IOF
Albert-Einstein-Straße 7, Jena 07745
GERMANY
Email: erik.beckert@iof.fraunhofer.de

Short biography

Erik BECKERT obtained a diploma in precision engineering in 1997 and a PhD in opto-electronics system integration in 2005, both from Ilmenau Technical University, Germany. Since 2001, he works at Fraunhofer Institute for Applied Optics and Precision Engineerig (IOF), where he is now a group leader for micro assembly and system integration. His research interests cover, besides assembly and packaging of miniaturized systems, also printing of functional materials and structures as well as quantum engineering.

High Temperature Suitable Bonding Technologies for Miniaturized Optomechanical Systems - Semiconductors, Crystals, Fused Silica, Ceramics and Metals Integrated in One Package

Bonding technologies for complex optical and opto-electronical systems often have to serve harsh environmental conditions such as high or low temperatures and steep temperature gradients, high humidity, high mechanical or radiation loads, vacuum conditions and more. Such conditions result in stringent requirements for the long-term stable fixation of components, which poses particular challenges for optics - heterogeneous materials integration, miniaturization, micron stability and low induced stress. The talk will focus on various technologies that allow for the bonding of typical optical materials such as glass, metals, ceramics, glass-ceramics and crystals, either using intermediate layers composed of polymer based glues, inorganic-metallic soft solder alloys or amorphous glasses, or preventing any intermediate layer by applying direct bonding technologies. Application examples cover laser-optical assemblies for various needs, such as sensors, quantum communication, and laser based ignition.