Ultrafast dynamics and control of laser induced structural modifications on mesoscopic scales: Application to laser photoinscription of optical materials

Laboratoire Hubert Curien, CNRS UMR 5516 Université Jean Monnet, Saint Etienne
Laser-mater interaction Group

The "Optics and Photonics" department at the Laboratoire Hubert Curien, CNRS UMR 5516, Jean Monnet University in Saint Etienne, France, is currently seeking a doctoral candidate for its research activities. Applications are invited for a doctoral position that will open in October 2011. The position is limited to three years.

Environment: Hubert Curien Laboratory is a mixed research unit, jointly run by the "Centre National de la Recherche Scientifique - CNRS" and the Jean Monnet University. The proposed subject concerns laser-assisted transformation of bulk optical materials on micro- and nano-scales and is framed within the research activity of the laser-matter interaction group. The Ultrafast laser platform located at the Hubert Curien Laboratory hosts state-of-the-art equipment for beam engineering, laser processing, and process characterization.

Project: Focused ultrafast laser radiation is capable of generating localized refractive index changes inside transparent materials with potential in developing integrated photonic systems. Particular issues are related to the mechanisms at work and the possibility of controlling the interaction physics for generating structures with required optical functions. The project proposes therefore an investigation into primary bulk laser excitation mechanisms via the development of real-time detection means in spectral and time domains; phase microscopy and spectral imaging. The emphasis is put on the correlation between the macroscopic properties (i.e. refractive index) with transformations at the molecular or mesoscopic level. Essential in refractive index design, the nonlinear propagation of spatio-temporally engineered pulses will receive a particular attention. The objective is to evaluate laser interaction with materials and to design modifications with desired optical response, in conditions where the vectorial character of the laser radiation is adequately designed. Towards this, the proposed subject involves the development and employment of automated vectorial spatio-temporal laser tailoring techniques, enabling concepts for "smart" functionalization of bulk optical materials. Using control adaptive loops, this serves for fabricating complex 3D optical instrumentation in emerging fields, e.g. integrated infrared optics for astrophotonics. Apart standard model glass materials, the mid-IR domains and the related materials will be particularly targeted. It is expected that the dynamic control over the energy delivery will allow a significant upgrade in the quality of the laser-induced structures and will enable ways of precise refractive index engineering, with new insights into the forming mechanisms.

Job description. The requested position includes as tasks the development of real-time imaging and spectroscopic methods required to observe the progress of laser-induced modifications in transparent materials, as well as the analysis of the excitation/relaxation events on short spatial and temporal scales. Pump-probe techniques with engineered pulses will be used. The question of controlling the subsequent material modifications using adaptive pulse spatio-temporal manipulation methods will be addressed. Specific developments in wavefront engineering will be followed (non-diffractive approaches, multispot division, polarization control). This knowledge will be used for fabricating 3D devices with optical functionalities. The forecasted research activity involves interaction with several ongoing graduate student projects but also interaction with spectroscopy and theory groups.

Candidate profile. Candidates should have a MSc degree (or equivalent) in physics or engineering, and show interest for interdisciplinary work in the field of laser-material interactions. The application should be supported by sound academic records and recommendation letters. Expertise is required in the following areas: ultrafast laser-material interactions, condensed matter, microscopy, solid-state physics, spectroscopy, ultrafast optics, linear and nonlinear optics, laser-induced ultrafast phenomena, photonics. Programming skills and a good command of English are also required.

Payment: Fellowship of the Ministry of Education

Duration: 36 months, **Application Deadline:** 15/04/2010

Contact (with customary documents: CV, letter of intent, recommendation letters.). Academic transcripts should be made available upon request.

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