Internship 2016

Institut Fresnel – Marseille

Phase imaging applied to the analysis of laser material interactions

Keywords: phase imaging, laser processing, laser damage, time-resolved measurements

Scientific background

Laser material interaction is an important study subject, with many industrial and scientific applications. The mechanisms of interaction are complex, because multiple physical effects can be involved: absorption, nonlinear effects, thermal effects (heating, phase changes…), mechanical effects (stress, shock waves ...), plasmas...To analyze topological changes of the surface of a material that has been irradiated by laser, a variety of imaging or profilometry techniques are available: Atomic Force Microscopy, optical or mechanical profilometry,....When it comes to detect internal changes such as a change in refractive index, optical techniques that are sensitive to the phase are the most used, but they cannot be calibrated easily.

Subject

The proposed work consists of using a new quantitative phase imaging technique, originally developed by the Fresnel Institute and Phasics company for biological applications. This technique, based on quadrilateral shift interferometry (ID4L) actually allows for calibrated optical delay measurements with an optical thickness sensitivity which can be sub-nanometer. Some early tests have been performed, which have already shown better sensitivity than currently used techniques (Nomarski microscope). The quantitative measurements should then allow studying more precisely the photo-induced changes by laser irradiation.

Thus, it will be for the trainee to validate and / or specify the terms of use of ID4L on samples of bulk materials or deposited in thin layers, and to use this technique to characterize different properties of irradiated sites. This work will require comparing ID4L measurements to other techniques available in the laboratory (confocal microscopy, AFM, electron microscopy, optical profilometry). Once this work is completed, the student work will be directed towards the implementation of ID4L in an original 'pump / probe' experiment to perform time-resolved phase measurements in order to study the dynamics of laser / material interaction process

The student will be based at the Fresnel Institute, as part of collaboration between the teams ILM (light-matter interactions) and MOSAIC (biophotonics). The supervisors will be Laurent Gallais (ILM) and Serge Monneret (MOSAIC). Serge Monneret developed the quantitative phase imaging system with Phasics company, initially for applications in biology; Laurent Gallais is interested in the physics and applications of laser / material interaction.

Perspectives

The subject could be continued with a PhD (application to different phD grants depending on the candidate profile).

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