

TIME-RESOLVED MEASUREMENTS AND LASER-INDUCED BIREFRINGENCE ANALYSIS OF LASER-MATTER INTERACTION BY QUANTITATIVE PHASE MICROSCOPY

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1. INTRODUCTION

A Quadri-Wave Lateral Shearing Interferometer (QWLSI) is an efficient tool for measuring wavefronts gradients and thus phase gradients of optical beams along two perpendicular directions. Post-processing integration then allows obtaining the complete phase spatial distribution of the beam with a high spatial resolution. By placing a QWLSI on the exit image plane of a microscope, we are able to measure the complex field spatial distribution in this plane, and then to retrieve the quantitative optical path difference of the observed sample, thanks to an additional reference measurement. Moreover, QWLSI is achromatic, and thus compatible with femto-second duration, pulsed illumination. Here, we demonstrate that we are able to produce time-resolved analysis of sub-picosecond phenomena, but also to produce birefringence maps of samples by inserting polarization control in the illumination path of the microscope.

2. TIME-RESOLVED ANALYSIS OF LASER-MATTER INTERACTIONS

Based on an experimental system that can be used for simultaneous laser damage testing and time-resolved acquisition of intensity and phase images, we describe different experiments related to the study of laser damage process in the sub-picosecond regime. We report firstly on quantitative measurement of the Kerr effect in a fused silica substrate at fluences close to the Laser Induced Damage Threshold. Then we study the damage initiation process in optical coatings, linked to intrinsic properties of the materials, and the dynamics of free electron generation and relaxation.

3. MEASUREMENT OF LASER-INDUCED BIREFRINGENCE IN FUSED SILICA

Thanks to a technical improvement of our technique, we are able to perform quantitative laser-induced linear birefringence measurement. The system combines a set of quantitative phase images with different orientation polarizations to provide birefringence distribution in the sample. Birefringence maps give then information about material properties, as the stress distribution induced by CO₂ laser processing of fused silica samples.

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