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Femtosecond Ablation Thresholds and Nanomachining – Measurements and Modeling

R. Fedosejevs, S.E. Kirkwood, R. Holenstein, and Y.Y. Tsui

Department of Electrical and Computer Engineering
University of Alberta, Edmonton Canada

Laser produced plasmas have a growing range of application areas in the microprocessing of materials. Demand for such techniques with micron lateral resolution and nanometer depth resolution is increasing with the growth of microelectronic, MEMS, integrated optical, microfluidic and biophotonic applications. One of the forefronts of micromachining processing is the removal of thin nanometer scale size layers of material, a new regime referred to as nanomachining. Such techniques are very useful to fine tune the response of high precision electrical or optical devices. A good understanding of the interaction physics near and just above the ablation threshold is required for such applications in order to achieve the precise control of the processing which is required. We have been studying the ablation of copper in detail and have accurately determined the femtosecond single shot ablation threshold and the incubation of multi-shot damage which leads to a significant reduction of ablation threshold for multiple shots interactions. In order to understand the microscopic processes which accompany such near-threshold ablation, a molecular dynamics modeling code has been developed which is currently applied to silicon. The results of both these experimental and theoretical studies will be presented with our latest understanding of the controlling processes.