University of Crete
Department of Physics

Physics Colloquium

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How a detailed description of ultrafast dynamics of laser-excited solids and the fundamental multiscale physics processes can lead to advanced material processing

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ABSTRACT

Over the past decades, the use of ultrashort pulsed laser sources for material processing and associated laser-driven physical phenomena has received considerable attention due to the important technological applications, in particular in industry and medicine. Various types of surface structures generated by laser pulses and, more specifically, the so-called laser-induced periodic surface structures (LIPSS) on solids have been studied extensively. Several laser-driven processes, including energy absorption, photo-ionization processes, electron excitation, electron-relaxation mechanisms, phase transitions and/or thermomechanical effects, resolidification, and mass ejection are some complex and highly nonlinear phenomena that need to be described and be coupled into a multiscale physical theoretical model to explain the self-organisation-based LIPSS formation. A thorough understanding of these laser-driven physical phenomena are expected not only to lead to an enhanced control of the laser energy for numerous potential applications but contribute to the fundamental understanding of the underlying physical processes. Hence, it is of paramount importance to develop appropriate modelling schemes that couple together processes on various timescales and provide precise and consistent description of the electron dynamics and lattice response following irradiation of a solid with ultrashort pulses. To address the above challenges, I will briefly present our research efforts towards beyond the state of the art, the development of a multiscale physical model to describe efficiently surface modification processes on various types of materials. A small part of the talk will also be devoted to our recent activities to support materials research with advanced predictive machine-learning based strategies.

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