ULTRASHORT-PULSE LASER EXCITATION OF DIELECTRIC MATERIALS: EXPERIMENTS AND MODELING

Peter Balling

1Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, DK-8000 Aarhus C, Denmark

The excitation of dielectric materials by ultrashort laser pulses is a topic of strong interest. From a fundamental viewpoint, its description represents an intriguing combination of strong-field excitation, charge multiplication and rapidly changing optical properties; for a recent review, see Balling and Schou (2013 Reports on Progress in Physics 76, 036502). From an applied viewpoint, the ability to modify the bulk and surfaces of a dielectric opens up for diverse applications as refractive-index modifications, micro-fluidics, thin-film production etc. The present paper will account for recent efforts to obtain new insight into the material-excitation dynamics for dielectrics by comparing extensive experimental observations with advanced simulations.

The starting point for the theoretical description is the so-called multiple-rate-equation description of dielectric excitation originally proposed by Rethfeld (2004 Phys. Rev. Lett. 92, 187401) and extended by us to include a self-consistent description of light-propagation effects, see Christensen and Balling (2009 Phys. Rev. B 79, 155424). The experimental approach combines time-resolved reflectivity and spectral interferometry with ablation-depth measurements in order to achieve observables over a large intensity span in one comprehensive experiment, see Wædegaard et al. (2014 Europhysics Letters 105, 47001) and (2014 Appl. Phys. A 117, 7).