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Laserové centrum HiLASE Vás srdečně zve na seminář

Propagation of powerful laser pulses in atmosphere: general effects of air presence and impact on laser processing of materials

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The vast majority of scientific and technological applications of short and ultrashort laser processing of various materials are performed in gas environment, mainly in air under atmospheric conditions. However, this topic is still not completely understood due to complexity of the phenomenon of laser beam propagation in non-linear ionizable medium and a large variety of involved processes. In this talk, the basics of laser beam propagation through air will be presented, such as Kerr non-linearity, critical power for beam self-focusing, mechanisms leading to air ionization, plasma defocusing, filamentation, etc. Several previous examples of our experimental and theoretical studies will be reported to demonstrate a dramatic role of air under conditions of laser processing of materials with laser pulses of duration from dozens of nanoseconds to dozens of femtoseconds. Finally, we will present recent studies performed at HiLASE on laser ablation of transparent dielectrics. To gain a better insight into observed difference of laser ablation in air and vacuum, experimental and theoretical investigations of fs-laser-induced gas ionization effects were performed, paying a particular attention to laser intensities typically used in material processing applications. Measurements of transmission of femtosecond laser pulses (800 nm, 120 fs) through the focal region have been carried out in air of various pressures and compared with the vacuum conditions. Spectroscopic study of air plasma emission was performed, indicating complicated dynamics of air ionization, dissociation, and recombination. A new effect has been discovered, strong dependence of transmission on pulse repetition rate at frequencies when laser-excited air volume has to relax (1 kHz – 1 Hz). The mechanism of the observed effect has been uncovered. A hydrodynamic modeling of the laser-induced plasma demonstrates an intriguing picture of the ambient gas motion in the focal region with formation of shock waves.

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