Ultrafast Advanced Optical Diagnostics for Gases and Plasmas

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Recent developments in advanced optical diagnostics based on ultrafast lasers enable non-intrusive high sensitivity measurements in gases and plasmas with high temporal and spatial resolution. These diagnostics rely on nonlinear optical effects to enable measurements such as electron and gas densities, species concentration [1], temperature, flow velocity [2] and electric fields [3] in low temperature plasma devices and other gaseous applications. The talk focuses on non-equilibrium temperature measurements using a hybrid femtosecond/picosecond Coherent Anti-Stokes Raman Scattering (CARS) spectroscopy technique [4], and on measurements of neutral atomic species such as O, N, and H using femtosecond Two-Photon Laser Induced Florescence (fs-TALIF). We present results obtained plasmas ranging from atmospheric discharge and arc jet plasmas, to low density plasmas found in magnetized RF heated devices, and in discharges at parameters relevant to tokamak divertors. Measurements of neutrals (H) in mTorr plasmas show densities as low as 10^{10} cm^{-3} with sub-mm spatial resolution, and the dynamics of the atomic species with nanosecond temporal resolution.

The work has been performed in collaboration with the Princeton Plasma Physics Laboratory (PPPL) and the Princeton Collaborative Research Facility (PCRF) under Contract No. DE-AC02-09CH11466 by the U.S. Department of Energy (DOE).

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