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Laser-based diagnostics and their applications to LTP

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Abstract - This talk presents several laser-based optical diagnostics using nonlinear atomic and molecular spectroscopic techniques and demonstrate their application in gases and plasmas. Powered by ultrafast lasers, these diagnostics enable measurements such as electron and gas densities, species concentration, temperature, and flow velocity in low temperature plasma devices and other gaseous application.

Laser-induced fluorescence has been widely used for species detection, imaging and temperature measurements in gases. The benefits of using femtosecond two-photon absorption laser induced fluorescence (TALIF) are demonstrated for measuring neutral density and dynamics in an RF plasma device. A novel microwave scattering technique allows resonantly enhanced multi-photon ionization (Radar REMPI) to be used for remote atomic spectroscopy and detection of gas traces. Radar REMPI also allows electron density and temporal dynamics measurements in devices such as atmospheric pressure plasma jets (APPJ) and Hall thrusters. A new velocimetry technique based on femtosecond excitation tagging (FLEET) provides species and velocity mapping in flows ranging from plasma jets to hypersonics. Coherent Anti-Stokes Raman Scattering (CARS) spectroscopy enables real-time standoff detection and identification of molecular species. In gases and plasmas, it also allows measuring non-equilibrium vibrational and rotational temperature. A hybrid ultrafast version of CARS is demonstrated in biomedical, homeland security, hypersonic applications, as well as in plasma devices. Finally, electric field induced second harmonic generation (E-FISH) is used to remotely measure electric fields in gases and plasma devices such as APPJ's and DBD's with high temporal and spatial resolution.

These optical diagnostics can be accessed by the LTP community as part of the new Princeton Collaborative Low Temperature Plasma Research Facility (PCRF) at Princeton University and Princeton Plasma Physics Laboratory (https://pcrf.pppl.gov/).

Brief Bio

Arthur Dogariu is a Research Scholar and Lecturer in the Mechanical and Aerospace Engineering Departments at Princeton University. He received his Ph.D. in Optical Physics from CREOL (School of Optics) at the University of Central Florida in 1997. Before joining Princeton, he was a research scientist at NEC Research Institute, and a researcher at the University of California, Santa Barbara. His research interests include experimental optical physics in the areas of nonlinear and ultrafast optics, biomedical optics, biosensors, remote detection techniques, hypersonics, plasma dynamics, photo-physics of organic materials and devices, ultrafast spectroscopy, nano-optics, quantum optics, wave propagation in dispersive media. Dr. Dogariu has authored over 90 publications in refereed journals, more than 150 conference papers, and 6 US and international patents. He is a member of the Optical Society of America, of the American Institute of Aeronautics and Astronautics, and an Honorary Member of the Academy of Romanian Scientists.