The AAE Spring 2019 Special Seminar Series

Presents

“Laser Diagnostics for Measurements of Electric Field and Excited Metastable Species”

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Abstract

Non-intrusive laser diagnostic measurements of temporal and spatial distributions of electric field and the number densities of excited metastable species in nonequilibrium plasmas are essential for development of engineering applications such as plasma flow control, plasma-assisted combustion, plasma materials processing, and plasma medicine. This talk presents an overview of recent electric field and species measurements in ns pulse discharge plasmas, by ps Four-Wave Mixing (FWM), ps Electric Field Induced Second Harmonic (EFISH) generation, Cavity Ring Down Spectroscopy (CRDS), and Tunable Diode Laser Absorption Spectroscopy (TDLAS). Picosecond FWM and EFISH have been used to measure electric field in dielectric barrier discharge plasma flow actuators, atmospheric pressure flames enhanced by transient plasmas, ionization waves and streamers, and atmospheric pressure plasma jets. Both techniques provide sub-ns time resolution. Electric field vector components are isolated by monitoring signals with different polarizations, and absolute calibration is done by measuring a known Laplacian field. The main advantage of EFISH over FWMis that it is considerably more sensitive and species independent, such that it can be used in any high-pressure plasma. Absolute time-resolved populations of N2(A3Σu+) excited electronic state, which is a major precursor of O atoms and NO in air plasmas, as well as H atoms and other radical species in fuel-air plasmas, are measured in a repetitive ns pulse discharge and the afterglow in nitrogen. N2(A3Σu+) is also a likely precursor of UV radiation (NO γ bands) behind strong shock waves. Two complementary techniques are used for these measurements, CRDS and single-pass TDLAS. The results demonstrate considerable potential of laser diagnostic techniques for characterization of high-pressure nonequilibrium plasmas, where they provide quantitative insight into kinetics of ionization, charge transport, molecular energy transfer, energy thermalization rate, and plasma chemical reactions.

Bio

Professor, Department of Mechanical and Aerospace Engineering, Chemical Physics Graduate Program, Ohio State University

2019, Visiting Professor, Clean Combustion Research Center, King Abdullah University of Science and Technology (KAUST), Jeddah, Saudi Arabia
2018, Gaspard Monge Visiting Professor, Ecole Polytechnic, Paris, France
2011, Japan Society for Promotion of Science Fellow, Department of Energy Science, Tokyo Institute of Technology, Tokyo, Japan
2010-2011, Visiting Professor, Department of Physics and Astronomy, Ruhr University, Bochum, Germany

Research interests include kinetics of nonequilibrium plasmas and high-speed nonequilibrium reacting flows, molecular energy transfer, plasma-assisted combustion, plasma flow control, plasma catalysis, molecular lasers, laser diagnostics, and kinetic modeling.

Service: Associate Editor, Plasma Sources Science and Technology. Associate Fellow, American Institute of Aeronautics and Astronautics (AIAA). Publications include over 140 archival journal papers, over 300 conference papers, over 80 invited lectures at national and international conferences, and 2 patents.