AEROSPACE & MECHANICAL ENGINEERING

2011 COLLOQUIUM 2012
SEMINARS ARE OPEN TO THE PUBLIC

INFORMAL COFFEE PERIOD BEFORE THE SEMINAR IN ROOM 365 FITZPATRICK HALL

UNIVERSITY OF NOTRE DAME, NOTRE DAME, INDIANA 46556

Founded 1842

SPEAKER: **Professor Igor V. Adamovich**
Michael A. Chaszeyka Nonequilibrium Thermodynamics Laboratories
Department of Mechanical and Aerospace Engineering
The Ohio State University
Columbus, Ohio

TOPIC: **NANOSECOND PULSE NONEQUILIBRIUM DISCHARGES FOR HIGH-SPEED FLOW CONTROL AND PLASMA ASSISTED COMBUSTION**

DATE: Tuesday, September 13, 2011

TIME: 3:30 p.m.

PLACE: 138 DeBartolo Hall

ABSTRACT

Recent experiments with repetitive nanosecond pulse discharges demonstrate their significant potential for engineering applications such as plasma assisted combustion, high-speed flow control, molecular lasers, and sustaining nonequilibrium hypersonic flows.

The main advantage of using repetitive nanosecond pulse discharges for ignition is efficient generation of electronically excited and radical species, such as O and H atoms and OH. In recent experiments at Ohio State, time-resolved temperature, absolute O atom and OH number density, and ignition delay time are measured in premixed ethylene-air and hydrogen-air flows excited by a spatially uniform, repetitive nanosecond pulse discharge in a plane-to-plane geometry. The experimental results are compared with kinetic modeling calculations using an analytic model of energy coupling to the plasma in a nanosecond pulse discharge and hydrocarbon/hydrogen/air plasma chemistry model, showing good agreement. The results demonstrate that ignition in a uniform plasma occurs in a large volume, due to efficient generation of radical species in the discharge. The results provide insight into the kinetic mechanism of low-temperature plasma assisted ignition.

The main advantage of using the repetitive surface nanosecond pulse discharge for high-speed flow control is rapid localized flow heating, on a time scale shorter than the acoustic time scale. This effect results in strong repetitive compression wave generation by the discharge at low time-averaged discharge powers. The temperature rise in the discharge is relatively modest, such that nanosecond pulse plasma actuators can be mounted on a surface of a plastic airfoil, generating large scale coherent structures (spanwise vortices) in the flow. Schlieren and PIV measurements in quiescent air demonstrate that this effect is purely thermal and different from flow entrainment by the ions in dielectric barrier discharge (DBD) plasma actuators powered by AC waveforms. The coherent structures transfer momentum from the freestream to the boundary layer and prevent its separation from the airfoil, at flow Mach numbers of at least M=0.3 and Reynolds numbers of Re~106. Nanosecond pulse plasma actuators, operated at a high pulse repetition rate (up to 100 kHz), generate repetitive shock waves in a M=5 flow over an actuator and can be used for bow shock control. The results show significant control authority of nanosecond pulse DBD plasma actuators in a wide range of flow velocities and static pressures.

NOTE: ***If you are interested in meeting individually with Prof. Adamovich, please contact Evelyn at 631-5431***