Michigan Institute for Plasma Science and Engineering Seminar

Energy Transport and Frequency Dependent Ion Kinetics in a Capacitively Coupled Plasma Reactor

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Wednesday, 9 Sept. 2009 - 4:00 pm, Room 1005 EECS.
(Refreshments will be served after seminar.)

Abstract

Precision plasma etching of microelectronics features requires exquisite control over the uniformity of the plasma across the wafer and of the ion energy distributions (IEDs) striking the surface. The IEDs influence etch rate and direction, surface roughening and critical dimension variations. IEDs also provide insights into spatially dependent energy deposition and flow within the plasma. Hot neutrals and ions may influence dissociation, ionization, detachment and surface processes in gases containing molecular species. Thus understanding and possibly controlling the temperature of plasma species may provide a way to tailor the chemistry in reactive gas systems.

The focus of our experimental work is the measurement of ion temperature (T_I), drift velocity and relative density across a 300 mm wafer in argon plasmas driven at rf frequencies between 13 and 162 MHz. Spatially-resolved, non-perturbative laser induced fluorescence (LIF) measurements of the argon ion metastable lineshape yield information on T_I and IEDs, ion density and drift velocity, energy deposition mechanisms, charge exchange reactions, neutral heating, and plasma potential gradients. We find that the ion density increased linearly with rf power, as did the electron density, indicating that the ion metastable state is formed from direct impact ionization. T_I was ≈500 K, consistent with other capacitively coupled systems at 13 MHz but considerably less than in inductively coupled systems (1000 – 9000 K). With large chamber size and high excitation frequencies (162 MHz), electrode dimensions are no longer small compared with the rf excitation wavelength, and so electromagnetic spatial effects and standing waves become important.

This work was supported by Applied Materials, DOE Office of Science and Sandia National Laboratories, a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company for the DOE National Nuclear Security Administration (DE-AC04-94AL85000).

About the Speaker:

Dr. Gregory A. Hebner received his BS, MS and PhD in Electrical Engineering from the University of Illinois. He joined Sandia National Laboratory in 1989 and is now Manager of the Lasers, Optics, Remote Sensing, Plasma Physics and Complex Systems Department. Dr. Hebner's research addresses development of novel plasma diagnostics using optical and microwave techniques focusing on understanding fundamental plasma physics and chemistry issues in technologically relevant gases. He has led many research activities, including programs in nuclear pumped lasers, plasma crystals and plasma etching sources. Dr. Hebner is a Fellow of the American Physical Society and the American Vacuum Society, and recipient of the AVS Plasma Science and Technology Division Prize and the DOE Weapons Award for Excellence.