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Electron Beam Driven Plasmas in O_2: Modeling and Diagnostics
SHAHID RAUF, Applied Materials Inc., Sunnyvale, CA 94085, DAVID R. BORIS, SCOTT G. WALTON, Naval Research Laboratory, Washington, DC 20375 — Electron beam driven plasmas are well-known for their low electron temperature (T_e), which leads to low plasma potential. These plasmas have been demonstrated as ideal sources for high-precision plasma processing applications such as atomic layer etching and functionalization of 2-dimensional materials (e.g., Graphene). Several diagnostic techniques were used to characterize magnetized electron beam plasmas in O_2. These diagnostics allowed measurements of spatially-resolved electron density, electron temperature and ion flux for a range of pressures, beam currents, magnetic fields and beam electron energies. As expected T_e was low (<0.3 eV) in these plasmas. There were however some surprises, such as a O^+ flux being higher compared to O_2^+ flux. This paper focuses on 2-dimensional modeling of the O_2 electron beam driven plasma with detailed comparison to experiments. The simulations utilized a hybrid plasma model with bulk electrons and ions treated as a fluid and a Monte Carlo model for the beam electrons. We will discuss the enhancements in the O_2 plasma chemistry that allowed the model to capture most experimental observations. This work is partially supported by the Naval Research Laboratory base program.

Shahid Rauf
Applied Materials Inc

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