GEC09-2009-000214

Abstract for an Invited Paper
for the GEC09 Meeting of
the American Physical Society

Development and validation of a C5F8/Ar/O2 mixture chemistry model using quantum chemistry methods

SONG-YUN KANG, Tokyo Electron Ltd.

Understanding the electron impact processes in c-C5F8 plasmas is of importance to low dielectric constant thin film deposition and etch process development. As much of radicals and excited states in c-C5F8 plasma chemistry are inaccessible by experiment, we used quantum chemistry methods, coupled with a zero-dimensional plasma kinetics model to develop an electron impact cross-section set and its associated plasma chemistry mechanism. The calculations were augmented with quadrupole mass spectrometry and actinometry measurements on a 200mm capacitively coupled plasma source. Predicted etch rates are in good agreement with experimental data examining large substrate RF bias and low pressure. The primary loss process for c-C5F8 is electron impact dissociation into isomers of C5F7 via excitation to the triplet state of c-C5F8. Electron impact dissociation of C5F7 isomers leads finally to the production of C5F5 (an isomer with two conjugate pi bonds) and C5F6 (an isomer with two pi bonds and a folded ring structure). These and other isomers characterized by a plurality of pi bonds and certain ring structures are very stable under electron impact. These "terminal" species are important from the perspective of polymer deposition. The etch precursor, atomic fluorine, is primarily produced from electron impact dissociation of the feed-gas and its degradation products. CF is produced from dissociation of CF2. CF3 is produced primarily from the walls.