GEC09-2009-020003

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

Reaction mechanisms in patterning complex oxide materials by plasmas

JANE P. CHANG, University of California, Los Angeles

The continuous down-scaling of the microelectronic and optoelectronic integrated circuits dictates the development of atomic layer deposition and high fidelity pattern transfer processes to synthesize and integrate novel materials, such as multifunctional oxides, into nanometer scaled devices. As the introduction of new gate dielectric materials in sub-32-nm metal oxide semiconductor field effect transistors (MOSFET) increases the complexity of the gate stack etch process, it is critical to formulate a comprehensive kinetics model to predict the physical and chemical effects of plasma chemistries on these complex gate dielectric materials. In this talk, I will highlight recent work on delineating the reaction mechanism in patterning complex metal oxides in halogen based plasmas. In general, the etch-rate scaled with the square-root of ion energy, and was dictated by the chemical nature of the dominant reaction ions in the plasma. The dominant metal-containing etch products were mainly MCl_x species, and their intensity and complexity increased with ion energy. A model was formulated to accurately describe the etching of composite oxide films in complex plasma chemistries involving competing deposition and etching mechanisms. This site balance-based model explains the etch-rate dependence on key plasma parameters including plasma chemistry/condition, neutral-to-ion flux ratio, and ion energy, as well as the film composition. The model fits well to a wide range of experimental data demonstrating its validity and potential application to various plasma etching processes.