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Experimental investigations of reactions in plasma etching of nanometer size structures

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As the size of features on semiconductor integrated circuits becomes ever smaller, patterning and pattern transfer processes must keep pace. Plasma etching is the only viable pattern transfer method today and it is likely to remain so in the foreseeable future. Selective etching of the silicon substrate or thin films results from the synergistic reactions of normal incidence positive ions and a non-directional flux of reactive neutrals. When considering the minimum feature size that can be replicated by plasma etching, unfortunately, several fundamental limitations appear to be looming. These include dimensions that do not scale with feature size: the depth of the disordered layers that form at the bottoms and sides of features, the thickness of protective layers that prevent the sides of features from eroding, and line edge roughness. In addition, an unprecedented control of the plasma etching process will be required, calling for a similar amount of control over the concentrations of plasma species, which in turn will require a high degree of control of the nature of the plasma reactor walls. This talk will review experimental studies from this and other laboratories that explore some of these issues in plasma-surface interactions at the substrate and at the chamber walls.