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Nanoscale Challenges in Plasma-Surface Interactions

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Plasmas have been used for many years in various thin film processing technologies to transfer patterns via etching. Recent developments in semiconductor device manufacturing have increased plasma etch challenges. The historic shrink in critical dimension continues apace. New photoresist materials tend to etch faster and roughen more than previous resists. Important plasma etch goals include controlling critical dimensions, maintaining high rates of etching, minimizing effects of local patterns, minimizing damage and contamination, and maintaining uniformity across 300 mm wafers. To achieve these goals, etch tool manufacturers often must explore a significant fraction of the enormous parameter space available in plasma etch tools, but with little guidance from fundamental understanding. In particular, a key problem is controlling feature shape with nanometer-scale precision. In this talk, I will describe results that focus on the principles of plasma-surface interactions, including the nature of the plasma-modified near-surface region, intrinsic nanoscale fluctuations during etching and the nature of plasma-induced surface roughness in organic polymers.