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Fundamental Etching and Roughening Mechanisms of Photoresist Polymers during Plasma Processing DUSTIN NEST, TING-YING CHUNG, DAVID GRAVES, UC-Berkeley Dept. of Chemical Eng., FLORIAN WEILNBOECK, ROBERT BRUCE, TSUNG CHENG LIN, RAY PHANEUF, GOTTLIEB OEHRLEIN, University of Maryland, College Park, ERIC HUDSON, Lam Research Corp., DEYAN WANG, CECILY ANDES, Rohm and Haas Electronic Materials — Reducing the etching and roughening of photoresist polymers during plasma processing is required as optical lithography for integrated circuit manufacture is extended to patterning features with critical dimension control on the order of nanometers. We use a vacuum beam system to simulate plasma exposure but under well-defined conditions. Samples are exposed to well-characterized beams of ions, vacuum ultraviolet (VUV) radiation, and electrons under high vacuum conditions. Post-exposure analysis includes atomic force and scanning electron microscopy and FTIR spectroscopy. We show that VUV radiation, ion bombardment, the ion / photon flux ratio and heating all play a role in the roughening of current-generation PMMA-based 193 nm photoresists. VUV radiation breaks carbon-oxygen bonds to a depth of approximately 100 nm whereas ion bombardment forms a dehydrogenated surface layer. Qualitatively similar roughening was observed in plasmas with the same ion bombardment energy and ion and VUV fluence.

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