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Photo-assisted etching of silicon in halogen-containing plasmas[1]
SHYAM SRIDHAR, WEIYE ZHU, LEI LIU, DEMETRE ECONOMOU, VINCENT DONNELLY, University of Houston — Cl_2, Br_2, HBr, and HBr/Cl_2 feed gases diluted in Ar were used to study etching of p-type Si(100) in a RF inductively coupled, Faraday-shielded plasma. Etching rates were measured as a function of ion energy. Etching at ion energies below the threshold for ion-assisted etching was observed in all cases, with Br_2/Ar and HBr/Cl_2/Ar plasmas having the lowest and highest sub-threshold etching rates, respectively. Sub-threshold etching rates scaled with the product of surface halogen coverage (measured by XPS) and Ar emission intensity (7504Å). Etching rates measured under MgF_2, quartz, and opaque windows, or biased grids, showed that sub-threshold etching is due to photon-stimulated processes on the surface, with VUV photons being much more effective than longer wavelengths. Scanning electron and atomic force microscopy (SEM and AFM) revealed that photo-etched surfaces were very rough, quite likely due to the inability of the photo-assisted process to remove contaminants from the surface. Photo-assisted etching in Cl_2/Ar plasmas resulted in the formation of 4-sided pyramidal features with bases that form an angle of 45° with respect to <110> cleavage planes, suggesting that the photo-assisted etching process is sensitive to crystal orientation, at least for chlorine.

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