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Origin of plasma-induced surface roughening and ripple formation during plasma etching KOUICHI ONO, NOBUYA NAKAZAKI, HIROTAKA TSUDA, YOSHINORI TAKAO, KOJI ERIGUCHI, Kyoto University — Atomic- or nanometer-scale roughness on feature surfaces has become an important issue to be resolved in the fabrication of nanoscale devices. Control of the surface roughening during plasma etching might be possible, given a deeper understanding of plasma-surface interactions concerned with it. We have investigated the origin of plasma-induced surface roughening and ripple formation during plasma etching of silicon in chlorine, based on a comparison of experiments with Monte Carlo-based atomic-scale cellular model simulations for surface feature evolution and classical molecular dynamics simulations for etch fundamentals. The experiments showed two modes of surface roughening which occur depending on ion incident energy: one is the roughening mode, exhibiting an almost linear increase of roughness with time; the other is the smoothing mode, retaining a smooth surface during etching, and smoothing of initially rough surfaces. The experiments also demonstrated the ripple formation in response to ion incidence angle onto substrate surfaces. These results are interpreted in terms of effects of ion reflection from microscopically roughened surfaces on incidence, which depend on incident ion species.

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