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Surface rippling by oblique ion incidence during plasma etching of silicon: Experimental demonstration using sheath control plates NOBUYA NAKAZAKI, HARUKA MATSUMOTO, KOJI ERIGUCHI, KOUICHI ONO, Department of Aeronautics and Astronautics, Graduate School of Engineering, Kyoto University — In the microfabrication of 3D transistors (e.g. Fin-FET), the sidewall roughness, such as LER and LWR caused by off-normal or oblique ion incidence during plasma etching, is a critical issue to be resolved, which in turn requires a better understanding of the effects of ion incidence angle θ_{i} on surface roughening. This paper presents surface roughening and rippling by oblique ion incidence during inductively coupled plasma etching of Si in Cl_2, using the experimental setup as in our previous study [1]. The oblique ion incidence was achieved by sheath control plates, which were placed on and electrically connected to the wafer stage. The plates had slits to vary the sheath structure thereon and to extract ions from plasma to samples on the bottom and/or side of the slits. The results indicated that at $\theta_{\mathrm{i}} \approx 40^\circ$ or oblique incidence; ripple structures were formed on surfaces perpendicularly to the direction of ion incidence, on the other hand, at $\theta_{\mathrm{i}} \approx 80^\circ$ or grazing incidence, small ripples or slit like grooves were formed on surfaces parallel to the direction of ion incidence, as predicted in our previous numerical investigations [2].

[1] N. Nakazaki *et al.*, J. Appl. Phys. **116**, 223302 (2014).
[2] H. Tsuda *et al.*, J. Vac. Sci. Technol. B **32**, 031212 (2014).

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