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Does charging affect surface roughness evolution of plasma etched polymeric substrates?

George Kokkoris, George Memos

NCSR Demokritos, Agia Paraskevi, Greece

g.kokkoris@inn.demokritos.gr

The prerequisites for surface charging during plasma etching is a dielectric substrate, inducing charge accumulation, with a surface morphology, facilitating local imbalance of positive and negative charges. This imbalance is provoked by the directionality difference between ions and electrons impinging on the processed surface. Even if plasma induced surface charging on conventional – with respect to the semiconductor industry – structures, i.e. trenches or holes, has been studied in previous works,[1] there is a lack of studies on the – inevitable during plasma etching – charging of rough polymeric surfaces. We have recently conducted a computational study on charging of unconventional (rough) polymeric surfaces[2]; this study has shown that charging may affect the evolving roughness of the etched surface. This is the focus of the current work: The effect of charging on the evolving roughness during plasma etching of polymeric surfaces is studied. The case study is Ar plasma etching of PMMA. A computational framework for profile evolution of unconventional 2d surfaces is developed. It comprises of models[2] for the calculation of a) ion and electron trajectories, b) local surface charge density, c) charging potential, a surface etching model, and a profile evolution algorithm.[3] The ion and electron trajectories are not only affected by the electric force emanating from the charging potential but they also affect it by changing the surface charge density. The local ion flux induces local etching with a rate which is calculated by the surface model. Surface profile evolution is realized by the feed of local etching rates to the profile evolution algorithm. Surface charging and etching progress simultaneously allowing the investigation of charging effect on surface roughness evolution.

[1] G. S. Hwang, K. P. Giapis, JVST B 1997, 15, 70. [2] G. Memos, G. Kokkoris, Plasma Process. Polym. 2016, 10.1002/ppap.201500176. [3] G. Kokkoris, A. Tserepi, A. G. Boudouvis, E. Gogolides, JVST A 2004, 22, 1896.

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