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Plasma Directed Assembly: Process Issues, Materials and Applications

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The modern trend in nanofabrication is the use of self or directed assembly methods to form periodic or semi-periodic patterns in the nanoscale. Block copolymer lithography and colloidal lithography are used mostly to create these patterns. Our group [1, 2] has shown that oxygen plasma can direct the formation of organized nanodots on the surface of PMMA films and then transfer the pattern to a subsequent Silicon substrate. With the use of a cryogenic plasma etching process we create high aspect ratio silicon nanowires or nanopillars. In this work, we first examine the generality of the phenomenon by looking if plasma directed assembly applies in other polymers. We study Polystyrene, a thermoplastic polymer more resistant to Oxygen plasma etching than PMMA, and PET a thermoplastic polymer which is widely used in food industry (it was chosen for potential future biological applications) and compare their morphology and dot characteristics with those of PMMA, thus generalizing our previous finding of plasma directed nanodot formation on PMMA [2]. The glass transition temperature of the polymer is proposed to play a role in the size and height of the created nanodots. Processing (etching) time was also examined as to how it affects nanodot formation, along with the size of the features created and their order. We observed a second mechanism emerging after a few minutes of processing time and a transition from a small size ordered nanodots to a bigger size mounds with embedded nanodots on their surface. Finally we measure reflectance of high aspect ratio structures created by plasma, both in polymers and silicon with the help of white light reflectance spectroscopy and UV-Vis spectroscopy.

References:
[1] E. Gogolides, et. al.; PCT/GR2009/000039, WO/2009/150479.
[2] N. Vourdas, et. al.; Nanotechnology 21 (2010) 08530.

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