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NANO SPOTLIGHTS

# A Nanopatterning Technique: DUV Interferometry of a Reactive Plasma Polymer

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Recently, great emphasis has been placed on the fabrication of chemical and topographical functional materials on both the micrometer and nanometer scale, due to novel phenomena that occur at this scale. Most techniques reported to date suffer from the ability to satisfy the different material requirements and makes it difficult to reproduce both topographical patterns with a wide range of well defined structures and chemical patterns with well defined geometries. Furthermore, the size of the patterns depends on the technique utilized and can often vary between the micrometer to the sub-10 nanometer length scale (Fig. 1).

One successful technique that has been utilized for functional surfaces is plasma polymerization. This technique allows the plasma-chemical surface functionalization step to be independent of the substrate, good adhesion of plasma polymer thin films with most substrates, surface density of immobilized molecular species to be finely tuned when the pulsed plasma duty cycle is varied and can be easily scaled to meet the required industrial dimension. In fact, maleic anhydride pulsed plasma polymerization has been well developed and used in numerous applications. These films have been useful because they readily undergo ring opening forming diacids after hydrolysis or reaction of amine functionalized molecule via aminolysis reaction (Fig. 2).

The study by Olivier Soppera from the *Département de Photochimie Générale* and his colleagues at the *Institut de Chimie des Surfaces et Interfaces, Université de Haute-Alsace* in France, has taken plasma polymerization to another level and demonstrated a new approach for patterning solid surfaces with reactive groups by utilizing the maleic anhydride pulsed plasma polymerization technique.

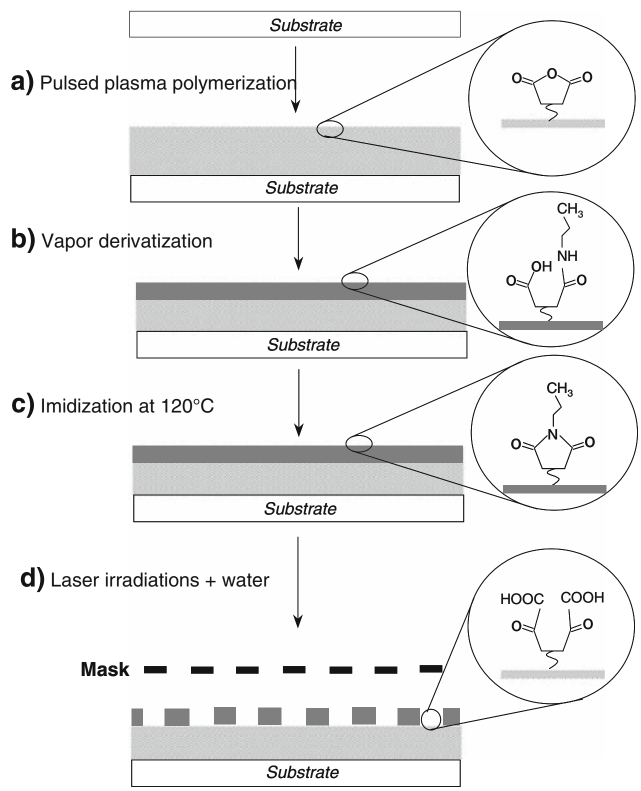


**Fig. 1** Plasma deposited polymer and UV-irradiation through a photomask

According to Soppera, an excimer laser was successfully used to address the surface patterning for lengths ranging from tens of micrometers to tens of nanometers. “The DUV lithography based on an interferometric approach allows a fast patterning on a large surface area (few $cm^2$). In addition, this is a versatile technique since the fringe

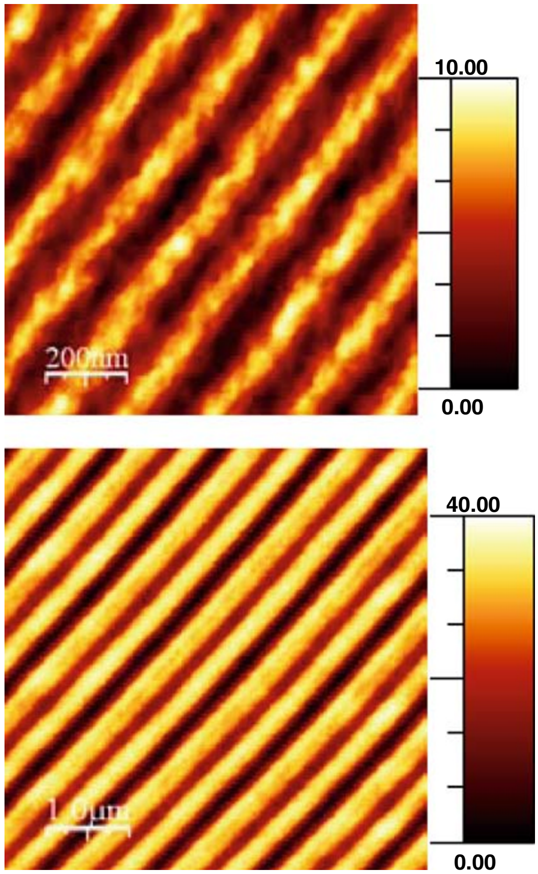


Fig. 2 Modification of the plasma deposited polymer surface by spatially controlled ArF irradiation (150 and 500 nm period pattern)—200–250 mJ/cm$^2$. Height scale in nm

spacing and the depth of the surface corrugation can be easily addressed by tuning the photonic parameters. We also demonstrate here that various geometries of patterns can be obtained by multiple irradiations." Soppera told Nano Spotlight (Fig. 3).

This approach developed by Soppera and his colleagues allows the generation of multi scale topographical or chemical images and creates combinatorial patterned surfaces. "This procedure opens thus a door to a control of

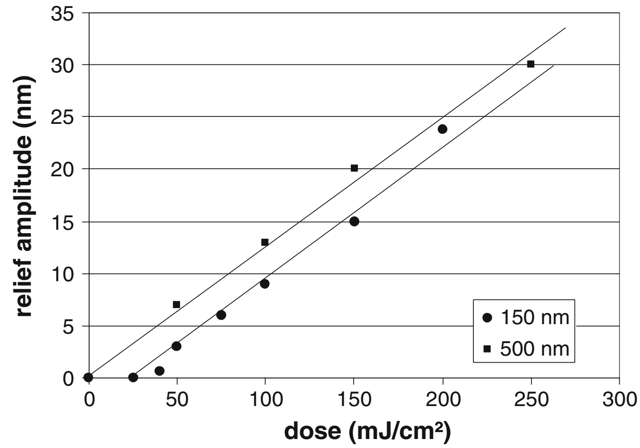


**Fig. 3** Evolution of the amplitude relief modulation with incident dose

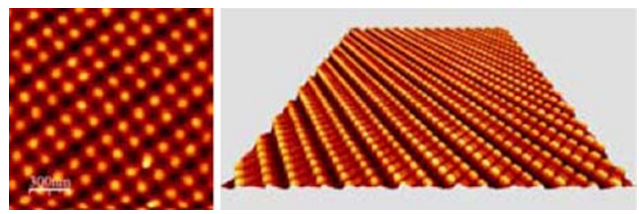

**Fig. 4** 2D periodic patterns generated by double exposure of the plasma deposited polymer film. (*Left*) both irradiation were carried out with a 300 nm phase mask. (*Right*) first irradiation was led with 300 nm and second irradiation with 1,000 nm phase mask (rotated of 90° from first irradiation)

both chemistry and topography on polymer films at different scales ranging from nano to macro. Great promises in the field of biology are expected from this work: we have already validated that such surface was compatible with cell or bacteria development. Such patterned polymer films appear as excellent candidate to study the effect of nanostructuration on the development of biofilms" said Soppera (Fig. 4).

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