POLYMER NANOSTRUCTURES GRAFTED ONTO POLYMER SUBSTRATES

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Lithographic exposure of polymer substrates followed by graft polymerization of a second polymer is a powerful technique to form patterns of polymer brushes[1, 2] (fig.1). EUV (extreme ultraviolet) interference lithography allows the formation periodic structures with nanometer scale resolution.[3]

In this work EUV interference was used to create periodic patterns of radicals at the surface of fluoropolymer films serving as initiators for the graft polymerization of glycidyl methacrylate (GMA). The epoxy groups of this polymer can be chemically derivatized to achieve specific chemical or biochemical functionalities.

Exposures of 100 µm thick poly(tetrafluoroethylene-*co*-ethylene) (ETFE) films were performed using 92 eV EUV radiation at the XIL beamline of the Swiss Light Source (SLS) at Paul Scherrer Institut. GMA was grafted onto the exposed ETFE films. Patterns of poly-(glycidyl-methacrylate) brushes down to 100 nm were achieved (fig. 2,3).
The dependence of the height of the grafted glycidyl methacrylate structures on the exposure dose and on the grafting parameters such as temperature, time and monomer concentration was studied with atomic force microscopy (AFM). Results show that spatial resolution of the process is critically dependent on the length and density of the grafted chains.

The described technique can be considered as an “additive” process for making polymer patterns, i.e.: no sacrificial layers are needed. In contrast, conventional lithography methods are “subtractive”, in that the entire substrate is coated with a polymer film, which is then removed selectively from certain areas.

This lithographic grafting process can be applied to many combinations of polymer supports and grafted monomers, as successfully demonstrated for styrene, acrylic acid and different methacrylates, enabling the preparation of a great variety of functional polymer structures with selected properties.

References:

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[3] H.H. Solak, C. David, J. Gobrecht, V. Golovkina, F. Cerrina, S.O. Kim, P.F. Nealey, Microelectron. Eng. 67-68, 56 (2003)

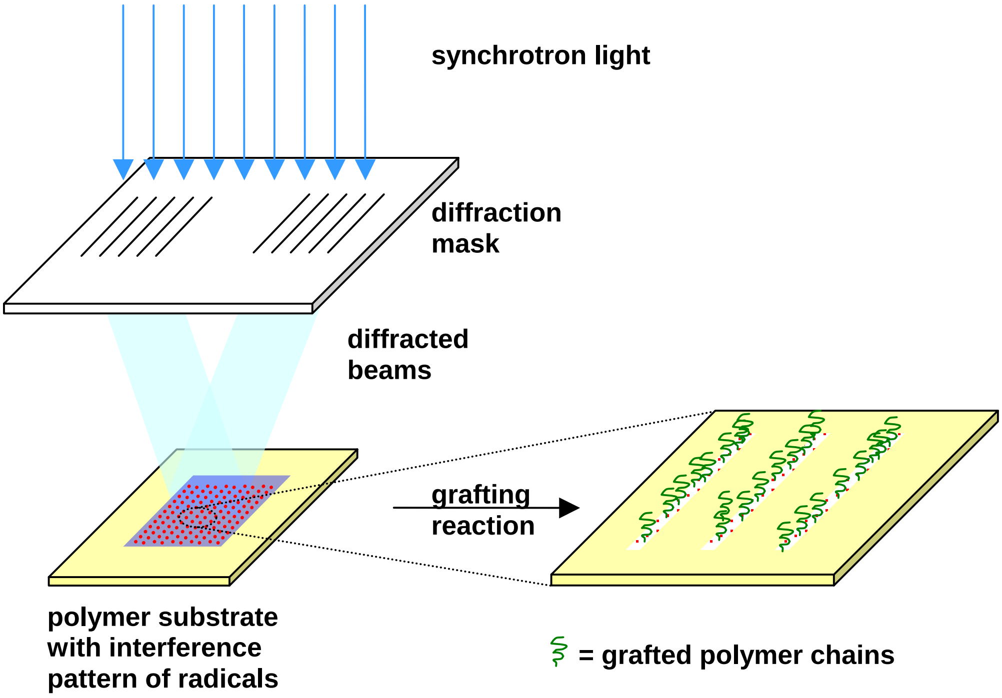

Figure 1: Scheme of the nano-grafting technique: interference exposure of a polymer film with EUV photons results in the formation of periodic patterns of radicals. These serve as initiators of a subsequent graft polymerization.

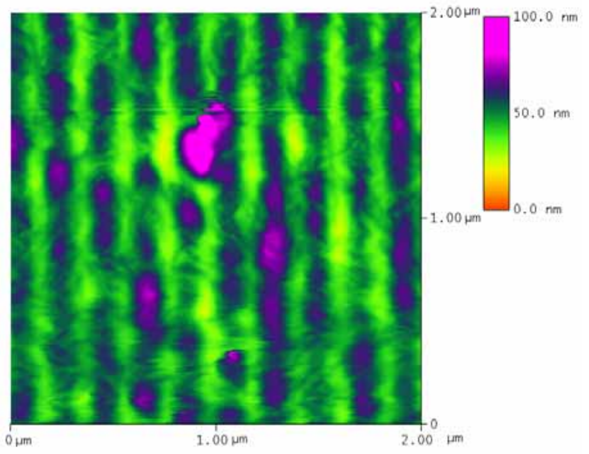	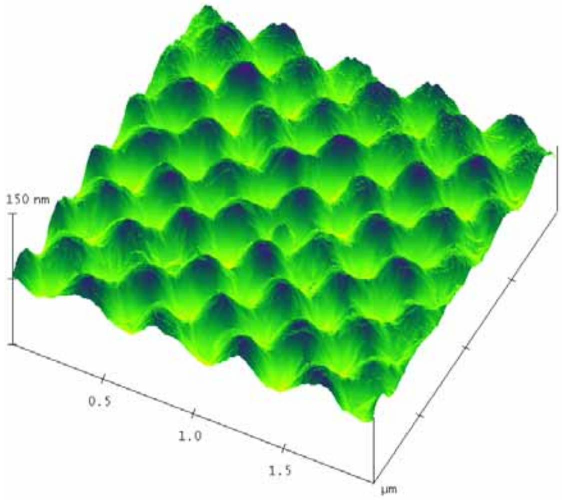
Figure 2: AFM image of 100 nm lines of glycidyl methacrylate brushes grafted onto ETFE after exposure to two interfering EUV beams.	**Figure 3:** AFM image of ETFE exposed to four EUV beams and grafted with glycidyl methacrylate.