Hierarchical soft-lithographic patterning of polymers on the micro- and nanometer scale

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The investigation and manipulation of hierarchical polymer patterns with structure sizes on the micrometer and the nanometre scale is of high technological importance for the development of polymer-based microsystems and devices. Two soft-lithographic techniques - solvent-induced nanoimprint and electrohydrodynamic lithography - will be presented in my talk which allow patterning of polymeric materials on these two length scales simultaneously.

In contrast to conventional nanoimprint lithography – which works at temperatures above the glass transition temperature of the resist polymer and under high pressures – we developed a process under controlled solvent-vapour atmospheres, so called solvent-induced nanoimprint lithography.[1] A topographically patterned stamp (mold) is embossed into a polymer film which is exposed to controlled solvent vapour before and during the imprinting process and exhibits strongly reduced viscosities. After evaporation of the solvent, the mold can be removed, and a patterned polymer film remains, which shows the replicated structure of the mold.

Electrohydrodynamic lithography is a technique in which the instability of dielectric liquids in electric fields is used to prepare structures with defined diameter and spacing. A polymer film on top of a substrate is brought in close face-to-face proximity with a second planar wafer, so that only a very small air gap remains. A voltage is then applied between the two plates resulting in an electric field within the polymer film. After heating above the glass transition temperature of the polymer or in the presence of solvent vapours, an instability of the polymer film appears which exhibits a characteristic wavelength. Upon touching the top electrode, columns are formed between the two plates. Whereas electrohydrodynamic lithography has been intensively studied for homopolymer films, we were interested in the influence of the patterning process on the self-assembly of block copolymers.[2]

In my talk I will present results on the influence of these patterning techniques on block copolymer self-assembly and the crystallization of conjugated polymers.

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[1] Voicu, N.E.; Ludwigs, S.; Crossland, E.J.W.; Andrew, P.; Steiner, U., Adv. Mater. 2007, 19, 757
[2] Voicu, N.E.; Ludwigs, S.; Steiner, U. Adv. Mater. 2008, 20, 3022