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Novel routes for 3D nanopatterning using soft matter: wave frontal growth and multi-axial surface instabilities.

Patterning of soft matter provides an exceptional route for the generation of micro/nanostructured and functional surfaces. Non-photolithographic methods are particularly attractive due to their simplicity and accessibility but also surface 3-dimentionality and varied surface chemistry. We exploit a well-known buckling instability of stiff supported layers under compression and report a novel approach, coupling controlled straining and simultaneous surface oxidation of an elastomeric membrane that is capable of generating large, model sub-micron periodic surfaces with unprecedented control. Single-frequency, uni- and multi-axial sinusoidal surface modulations, with tunable amplitude and wavelength, in the nano to micrometer range, are readily demonstrated. Applications of this inexpensive and fast methodology include stamps for soft lithography, micromolding, templating and surface patterning.

We will then describe the propagation of planar wavefronts of network formation emanating from an illuminated surface during photopolymerisation and report a 3D patterning approach, which is particularly attractive for organic microfluidics. Photopolymerisation is a complex spatio-temporal process that may lead to well-defined fronts, both stable and unstable. We investigate this light-driven frontal photopolymerisation (FPP) process with a combination of experiments, analytical and numerical modelling. Frontal growth of a series of multifunctional polymers is quantified and described with a 'minimal' coarse-grained model, in terms an order parameter phi(x,t) characterising the extent of monomer-to-polymer conversion. The non-trivial aspects of FPP derive from the coupling of optical attenuation coefficient miu(x,t) and the growing non-uniform network h(x,t). The effect of temperature and nanoparticle fillers (silica, titania, and carbon nanotubes) is elucidated and agrees remarkably with model predictions. Using these results, FPP is implemented as a contact photolithography 3D fabrication process. We demonstrate a series of microfluidic approaches to the synthesis and study of complex fluids, with particular emphasis to tailoring complex flow fields using microchannel topography generated by FPP.

Viernes, 9 de Enero de 2009 12:00 horas.
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