Waves of Photopolymerisation, Frontal Instabilities and Novel 3D Patterning Routes

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Patterning of soft matter provides exceptional routes for the generation of micro/nanostructured and functional surfaces, for controlled adhesion, wetting, spreading and fouling, drag reduction or anti-microbial properties. We describe the propagation of planar wavefronts of network formation emanating from an illuminated surface during photopolymerisation and report a 3D patterning approach based on coupling planar growth with precisely controlled, yet spontaneous, interfacial instabilities. Photopolymerisation is a complex spatio-temporal process that may lead to well-defined solidification 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 radical monomers can be quantified and described with coarse-grained models characterising the extent of monomer-to-polymer conversion [1-3]. The non-trivial aspects of FPP derive from the coupling of optical attenuation coefficient and the growing non-uniform network, and can be readily modulated by chemical formulation and light processing, as well as by the effects of temperature. Using these results, FPP is demonstrated as a photolithographic 3D fabrication process [4], avoiding multiple illumination steps.

References

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