Theoretical aspects of patterning polymer films via evaporative lithography and composite substrates

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The continuing development of evaporative lithography is important for many areas such as the creation of photonic crystals for optronics and microelectronics, the development of biosensors for medical applications and biotechnology, and for the formation of functional coatings for nanotechnology, including the application of thin, protective polymer coatings. The article proposes a mathematical model that allows us to explain the basic mechanisms of the formation of thin polymer films (less than 50 μm thick) during their deposition onto a composite substrate by methanol evaporation from a solution. If the thermal conductivity of the substrate is spatially non-uniform, this results in inhomogeneous evaporation along the free film surface. Therefore, as the film dries, a patterned polymer coating is left behind on the substrate. The mathematical model described here is based on the lubrication approximation and takes into account the dependence of the solution density on the concentration [1]. The numerical computation results are in qualitative agreement with the experimental data of other authors [2]. The article shows that solutal Marangoni flow plays a primary role in the process under consideration. This study allows us to better understand the mechanisms that can be used in evaporative lithography.

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