Surface Energy Driven Marangoni Flow in Polymer Films to Generate Topographic Patterns

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When a polymer film containing surface tension gradients is in its melt state, Marangoni convection of the film material can spontaneously occur toward the localized regions of higher surface tension. In this presentation, we report a photochemical strategy to harness the Marangoni flow as a versatile patterning method. To generalize this approach, a theoretical model that gives the underlying physics of this process will be presented along with comparisons between model predictions and experimental observations. The validated model reveals that the maximum film thickness variations are favored by large surface tension gradients, low diffusivities and viscosities. A lower viscosity promotes a faster feature formation rate. However, as described by the Rouse model, low viscosity generally results in high diffusivity which rapidly reduces the surface tension patterns. This coupled diffusivity and viscosity critically limit feature height for a given surface tension pattern. Therefore, a strategy to decouple diffusivity and viscosity of the film components to form larger features rapidly will be described.