Self-Assembled Templates for Device Fabrication on Si Wafer and Roll-to-Roll Process Platforms

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Presentation

Abstract: The fabrication of nanotechnology enabled devices requires not only the creation and functionalization of well defined nanostructures, but also practical routes for the two and three dimensional integration of these structures with components and systems across multiple length scales. Approaches for the use of self-assembled block copolymer templates to achieve these goals for sub-10 nm elements using either Si wafer or roll to roll processing platforms will be discussed. While the potential for these materials for patterning precision electronics, including high density data storage is an area of active study and great promise, less work has been carried out to adapt these strategies for lower cost per function devices, including solar energy applications and flexible electronics. For example, use of self assembly in roll to roll processes to achieve these goals requires the development of versatile, low cost templates.

Recently we reported that nanostructured templates with sub-10 nm domains can be easily obtained through the blending of disordered polymer surfactants containing poly(ethylene oxide) (PEO) as the hydrophilic block with homopolymers including poly (acrylic acid), poly (4-vinyl phenol) and poly (styrene sulfonate) that selectively associate with the PEO block through hydrogen bonding. These inexpensive blends are strongly segregated, yielding well ordered domains. Moreover, the functionalities imparted by the homopolymers provide convenient handles for binding active materials such as nanoparticles and for promoting in situ, phase selective reactions to produce hierarchical metal oxide polymer composites. We have now extended our approach to demonstrate that ordering can likewise be induced by small molecule additives that can undergo multi-point hydrogen bonding with the surfactants. The use of small molecule additives offers additional structural, chemical and functional diversity. The behavior of the template systems and their use for the fabrication of well ordered polymer/nanoparticle, metal oxide/polymer, and metal oxide/polymer/nanoparticle composites will be discussed.