Exploring the Versatility of End-Grafted Polymer Brushes for High-Precision Nanopatterning

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End-grafted polymer brushes emerge as compelling alternatives for nanoscale surface modification, showcasing a variety of functionality and versatility options not available with conventional organosilicon compounds or self-assembled monolayers. When integrated with advanced lithographic patterning techniques, these brushes create chemical contrast at the nanoscale, unlocking new possibilities for targeted adsorption, tuning interfacial energies, and facilitating interfaces between inorganic surfaces and biological matter.

An intriguing property of graft-to polymer brushes lies in their capability to interpenetrate existing polymer layers. Often perceived as undesirable, this property can be strategically exploited to enhance surface properties and achieve nano-patterned multi-color surface treatments. The interplay of polymer interpenetration and diffusion-based delivery mechanisms provides nuanced control for precise surface functionalization at the nanoscale.

More recently, sequence-defined biomimetic polypeptoid brushes have emerged as yet another possibility to add precise functionality at prescribed locations along the polymer backbone. Coupled with lithographic techniques, these polypeptoids can unlock new possibilities to interface inorganic surfaces with biological matter.

We present here three recent examples that underscore the versatility of polymer brushes in diverse nanopatterning applications. We illustrate how end-grafted linear polymers, acting as "inks" within block-copolymer matrices, can be precisely delivered to targeted locations. Additionally, sequence-defined biomimetic polymer brushes demonstrate selective biomolecule binding at specified locations, while a third application focuses on leveraging polymer brushes to enhance growth rates in area-selective deposition. These varied demonstrations span applications from biomimetic polymers for semiconductor/bio interfaces to directed self-assembly for EUV lithography and selective deposition, highlighting the adaptability of functional polymer brushes for precision nanopatterning.