Micro- and Nano-Structured, Bio-Functional Block Co-Polymer Interfaces for High-Avidity Bacteria Capture

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Synthetic biointerfaces that combine micro- and nano-scale structures with chemical functionality have a variety of applications in microbiology, ranging from antifouling surfaces to surfaces designed for microbial capture and isolation. In addition, synthetic interfaces can be designed to systematically mimic features of natural host surfaces, providing new insight into the roles that surface cues play in driving microbial attachment and community structure. Interfaces that combine precisely controlled micro- and nano-structure with chemical functionality will allow for continued advancement in these applications.

In this work, we develop micro- and nano-structured, bio-functional polymer interfaces with unique binding capabilities for high-avidity bacterial capture. Surfaces are patterned with a chemo-selective block co-polymer, poly(glycidyl methacrylate)–*block*–poly(vinyl dimethyl azlactone) (PGMA-*b*-PVDMA). Upon surface-coating and thermal annealing, the GMA block of this polymer covalently couples with oxide-bearing surfaces, while the VDMA groups remains available for protein coupling (Figure 1A). Reactive oxide patterns can be used to direct the self-assembly of patterned, brush-like structures 90 nm in thickness (Figure 1B). These brushes are organized at the nanoscale and allow for precise control of chemical surface reactivity towards biomolecules.

Recent findings have shown that PGMA-*b*-PVDMA surfaces can be modified with lectin proteins at amplified surface densities due to the high levels of reactive VDMA groups present. This allows for three-dimensional lectin “clusters” that promote multi-valent binding interactions with bacterial exopolysaccharides. After incubation with solutions of *Psuedomonas* microbes, functional polymer surfaces have shown improvements in the numbers of cells captured, particularly in regions containing pronounced microscale topology and high nanoscale roughness. Current work is focused on quantifying the gains in binding affinity and cell capture efficiency due to three-dimensional structure and lectin surface density, as well as optimization of these parameters for highly-sensitive bacterial isolation in flow-based assays. This advancement would overcome the inherently weak binding affinities and low sensitivities that have traditionally inhibited otherwise promising lectin-based capture strategies for the detection of microbial contamination in clinical or environmental samples.

Figure 1. (A) *Self-assembly of protein-reactive block co-polymer brushes using chemical micropatterns. (B) AFM images of PGMA-b-PVDMA brushes after self-assembly.*