Towards autonomic surfaces: Polymer brushes, enzyme immobilization and spatial-temporal modulation of surface properties.

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In creating smart surfaces, polymer brushes offer several advantages over the traditional self-assembled monolayers. These advantages include a higher surface area, and thus more anchoring points for immobilizing any desirable molecule such as a fluorophore or protein. Certain polymer brushes also exhibit thermo-responsive or pH-responsive hydrophobic-hydrophilic transitions, which can be utilized in a number of different ways, such as changing the surface energy of the brush or accessibility of molecules immobilized on the surface. We have developed a versatile platform technology based on activation of poly-hydroxyethylmethacrylate (pHEMA) brushes with N’N’-disuccinimidyl carbonate (DSC), which enables spatial patterning via soft-lithography of immobilized, functional nano-units such as gold nanoparticles and enzymes. For example, prescribing time-temperature cycles, PEG-pHEMA brushes exhibit reversible size-selective, capture and release of Au nanoparticles. In the case of the immobilized enzymes, such as horseradish peroxidase (HRP), computer simulations using Autodock and molecular dynamics indicate that the lysine residues K174, K149 and K84 are the most probable to react with the activated brush, resulting in retention of the protein’s secondary structure, consistent with the experimentally verified retention of activity. Furthermore, current efforts include using different brush grafting densities and thermo-responsive polymer brushes, such as poly(N-isopropylacrylamide), formed on top of the PHEMA, for modulating the accessibility of the enzyme.