ENVIRONMENTALLY RESPONSIVE BLOCK COPOLYMERS AS ANTI-BIOFOULING SURFACES

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Biofouling of ship-hulls is a problem of significant economic and environmental consequences. The accumulation of 'slimes' of microorganisms such as bacteria, green algae and diatoms, followed by the attachment of macroorganisms such as hydroids, sponges and barnacles, causes increased frictional drag on ships, higher consumption of fuel, and greater emission of greenhouse gases [1]. That marine biofouling is a difficult problem to tackle is evident from the fact that all currently available coatings, including the ablative-copper antifouling paint used by the US Navy, get rapidly covered by fouling organisms. The tributyl tin or copper based coatings, which rely on deterring fouling by releasing toxic chemicals into the marine environment, are successful against barnacle fouling but much less effective in addressing microbial slime. Within a year of immersion in water, these toxic coatings showed up to two-fold increase in drag coefficient due to microfouling alone [1].

Our goal is to develop environmentally friendly, non-toxic polymers that are effective against both micro- and macrofouling. Our initial coating system comprised of self-assembling, semifluorinated block copolymers. The liquid crystalline fluoroalkyl moieties in these polymers created highly non-polar surfaces that were resistant to underwater reconstruction. These hydrophobic surfaces were effective against green algae, but showed strong adhesion of diatoms [2]. Diatoms, on the other hand, could attach only weakly to a second coating system based on hydrophilic PEGylated polymer [2]. We hypothesized that environmentally responsive surfaces consisting of both fluorinated and PEGylated moieties would show fouling resistance against a broader range of organisms. Hyperbranched polymers with amphiphilic characteristics had been previously shown to resist adhesion of green alga [3]. Thus, we synthesized non-crosslinked and spray-coatable polymers with PEGylated fluoroalkyl side-chains, using polymer analogous reactions on ATRP-based block copolymers precursors [4]. The resulting amphipathic surfaces showed very weak adhesion of microbial slimes (green algae and diatoms) [4], highly promising antifouling properties against barnacles [5], and a resistance to protein adsorption that was comparable to widely studied PEG. This poster will discuss physicochemical characterization of surfaces of the comblike amphiphilic block copolymers. Surface sensitive X-ray absorption techniques such as NEXAFS were used for compositional depth profiling in the top 1–3 nm of the surface. Block copolymer microstructure determination was possible using GISAXS. The use of lithographically patterned model amphiphilic surfaces to understand cell response to wettability gradients will also be presented. The role of polymer–water interfacial energy in cell–surface interactions will be discussed.

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