Contribution ID: **19**   Type: **Contributed Talk or Poster**

UV-Activated Crosslinking of Polyzwitterionic Ultra-thin coatings for Enhanced Anti-fouling Performance

Antifouling strategies aim to prevent the adhesion and growth of unwanted biological organisms, such as bacteria, algae, and proteins, on material surfaces. Polyzwitterions, a subclass of polyampholytes bearing both positive and negative charges on each monomer, have shown exceptional antifouling capabilities due to their strong hydration layers and high surface energy, which together form a robust barrier against biofouling. In this study, we investigate ultrathin polyzwitterionic coatings based on poly(2-vinylpyridine propanesulfonate) (P2VPPS), synthesized via free-radical polymerization, for their antifouling performance. A benzophenone-functionalized silane was covalently attached to SiO_2 substrates to enable UV-induced crosslinking of spin-coated and drop-cast P2VPPS films. Controlled exposure to 365 nm UV light produced coatings with varied crosslinking densities and thicknesses. The resulting films were characterized using X-ray photoelectron spectroscopy, X-ray reflectometry, contact angle goniometry, atomic force microscopy, and sum frequency generation spectroscopy. Antifouling performance was evaluated through protein adsorption studies with β-casein using quartz crystal microbalance with dissipation (QCM-D) and neutron reflectometry, as well as microbial attachment assessments via multi-scale imaging of Pantoea sp. The results reveal that light-induced crosslinking significantly alters film structure and surface properties, with higher crosslinking levels correlating with increased thickness and protein retention. These findings highlight the tunability of polyzwitterionic coatings for antifouling applications through light-controlled crosslinking strategies.

Topical Area

Soft matter: polymers, and complex fluids

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