Bio-based Reactive Surfmer for Water-Resistant Acrylic PSAs

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Waterborne pressure-sensitive adhesives (PSAs) prepared by oil-in-water emulsion polymerization commonly rely on low-molecular-weight surfactants. While effective for latex stabilization, these additives can remain mobile after film formation, enriching at interfaces and undermining water resistance and adhesion durability under wet conditions. Here, we introduce a biomass-derived reactive surfactant (surfmer) designed to mitigate such post-film migration while maintaining robust colloidal stability. The surfmer is synthesized from 10-undecenoic acid (castor-oil-derived feedstock) and incorporates an allyl-ether functionality that allows covalent incorporation during acrylic emulsion polymerization. Notably, stable latexes were obtained using this surfmer as the primary stabilizing species, enabling surfactant immobilization within the polymer network.

Surface-sensitive spectroscopy indicates a markedly reduced enrichment of the bio-surfmer at the air-film interface compared with a conventional anionic surfactant reference, consistent with suppressed “blooming” during drying. This interfacial stabilization translates into substantially improved water tolerance of the resulting PSA films, as evidenced by significantly lower water uptake and better retention of adhesive performance after aqueous exposure. In parallel, mechanical testing reveals enhanced cohesive integrity at increasing surfmer incorporation, which we attribute to ionic associations acting as reversible physical cross-linking domains within the adhesive matrix. Adhesion on a pigskin model substrate further highlights the practical impact: formulations based on the reactive bio-surfmer show sustained peel resistance after saline immersion, whereas the control exhibits pronounced degradation (and loss of cohesion).

Overall, the work demonstrates how a sustainable, inedible biomass-based surfmer can couple latex stabilization with interfacial and bulk-property control, offering a promising route to high-performance PSAs for moisture-challenging applications.

Keywords:

reactive surfactant (surfmer), emulsion polymerization, pressure-sensitive adhesive, surface migration, wet adhesion, biomass-derived materials