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Inverted grafting-to key to superior aqueous friction

The ability to control lubrication is essential to avoid damage of the underlying material and to ensure low energy dissipation in biological and man-made mechanical systems. An initial systematic approach to lower the surface friction of wet PDMS surfaces employed adhesion of various novel amphiphilic block or graft copolymers prepared by the controlled radical polymerization techniques, ATRP and RAFT. The concept is relying on adsorption of the hydrophobic blocks onto the PDMS surface while the neutral or charged buoyant blocks should provide the lubricity in the aqueous phase. The systematic study concluded that only moderate, non-lasting lubrication of the PDMS surfaces could be achieved. Alternatively, the anchoring of hydrophilic polymer brushes onto surfaces by grafting seems as a more powerful mean to render materials slippery in aqueous environment. Nevertheless, presently available approaches to graft polymer brushes onto surfaces, "grafting-from" or "grafting-to", pose severe restrictions both in terms of practical and long-term applications. Here we like to advocate the novel concept: "inverted grafting-to" that forms hydrophilic polymer brushes by selective segregation of hydrophilic chains of amphiphilic diblock copolymers, PDMS-b-PEG or PMDS-b-PAA, from a PDMS matrix. The block copolymers are prepared by "click chemistry" or ATRP by use of the macroinitiator concept, respectively. Excellent grafting stability and restoring capabilities are achieved as revealed even under harsh tribological testing since the hydrophilic polymer brushes are generated from an internal source of the material. The film can easily be applied to elastomers, metals and ceramic substrates by spin- or drip coating. The resulting sliding friction coefficients (μ) are 0.001 to 0.05 for soft contacts depending on substrate, load, counter surface, pH and salinity. Here, the hydrophilic PAA shows much superior lubricity compared to PEG, which is rationalized by larger reduction of total free energy of the former upon hydration.

Biography

Søren Hvilsted is a Professor of Polymer Chemistry at the Technical University of Denmark. His research interests entail the design, preparation and testing of stimuli-responsive polymer materials. Particular attention is devoted materials for optical information storage and fuel cell electrolyte membranes, as well as fluorinated materials and polymers for biomedical, drug release and sensor applications. This approach involves preparation of entirely new monomers as well as application and optimization of several of the newest controlled polymerization techniques. In addition, the imperative and advanced analytical techniques such as SEC, FTIR, NMR, TGA and DSC are closely followed and external strategic alliances are formed when local accessability is not possible.

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