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Functionalization of Membrane Surfaces to Develop Smart Membranes and Low-Biofouling Feedspacers

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Smart Membranes: We produced a low-fouling membrane by attaching a stimuli-responsive polymer brush on the surface, which offers the potential to collapse or expand the polymer brush. The phase change arises from the existence of a lower critical solution temperature (LCST) such that the polymer precipitates from solution as the temperature is increased. This capability can be exploited to control adsorption/desorption. A temperature decrease can cause the brush to expand into a hydrophilic state while a temperature increase causes a collapse into a hydrophobic state. Organic matter fouling is reduced in the expanded, hydrophilic state relative to the collapsed, hydrophobic state. By continuously triggering the phase transition, the non-equilibrium movement of the polymer brush may offer better protection of the surface than at equilibrium. Increasing temperature to collapse the brush and immediately decreasing temperature to expand it would create a sweeping motion at the molecular (nanometer) level along the surface. The surface of a cellulose acetate membrane was grafted with a thermally responsive brush layer. When attached to the membrane surface, the brush layer collapses upon increasing the temperature above the phase transition temperature and expands away from the surface when cooled.

Low-Biofouling Feedspacers: Implementation of nanofiltration (NF) and reverse osmosis (RO) processes in treating traditional water sources can provide a steady-state level of removal that eliminates the need for regeneration of ion exchange resins or granular activated carbon. Moreover, RO can help meet future potable water demands through desalination of seawater and brackish waters. An optimistic view for the future of membrane technology must be tempered, however, by recognition of the technical and cost issues that remain to be addressed. Of these issues, the fouling of membranes by chemicals and microbes that are rejected continues to demand considerable attention. Microbial fouling, or biofouling, is the accumulation of microorganisms onto the membrane surface and on the feed spacer as present between the envelopes. The goal of this project was to develop anti-biofouling polypropylene (PP) films, to be used as membrane feedspacers, through the functionalization of PP by a spacer arm with metal chelating ligands charged with copper ions. Virgin and modified PP films were put in contact with 3.0×10^5 *e.coli* cells/mL solutions for periods of time varying from 24 to 168 hours. Invariably, the modified PP films showed an order of magnitude lower microbial attachment than on the virgin PP. Further, over a period of time of 2 weeks, no significant amounts of copper leached from the anti-biofouling PP films.

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