Bacterial Anti-Adhesive Properties of Membranes Modified with Polyelectrolyte Multilayers

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Abstract:
Low-pressure membrane (LPM) filtration, including microfiltration (MF) and ultrafiltration, has been gaining popularity in drinking water treatment and wastewater reuse because of its effectiveness in removing pathogenic microorganisms and particulate matter, small footprint, and relatively low costs. However, LPM filtration processes are often hindered by biofouling which results in higher operating pressures, frequent chemical cleaning, and shortened membrane lifespan. To overcome these limitations, we investigate the surface modification of polymeric MF membranes with the use of polyeletrolyte multilayers (PEMs) to enhance their resistance to biofouling. Specifically, commercially available polysulfone (PS) membranes are modified with poly(allylamine hydrochloride) (PAH)/poly(acrylic acid) (PAA) multilayers using the layer-by-layer deposition technique in order to increase the membranes' resistance to bacterial adhesion. The surface properties of the base PS and PAH/PAA modified membranes are characterized by using ATR-FTIR, XPS, and SEM. Cross-flow membrane filtration experiments are conducted with *E. coli* suspensions prepared at either 10 mM NaCl or 1 mM $CaCl_2$. By using a fluorescent microscope, the deposition of fluorescent *E. coli* cells can be observed through a window on top of the membrane cell in real time. The initial bacterial deposition rate coefficient (k_d) is obtained by enumerating the deposited bacteria during the first 20 min of deposition. The reversibility of bacterial attachment is also investigated by flushing the deposited bacteria at zero transmembrane pressure with the same background solution as that used for the deposition experiment, followed by 1 mM NaCl solution. Our results show that the modification of membranes with PEMs led to a considerable reduction of k_d. Moreover, the reversibility of bacterial attachment was significantly enhanced for the PEM-modified membranes. Interaction forces between the membranes and carboxyl-modified latex colloid probes will be measured using an atomic force microscope in order to elucidate the mechanisms for the anti-adhesive properties of PEM-modified membranes.