Regenerable Coatings of Functionalized TiO_2-PA(-) and Ag-PA(-) Nanoparticles on Reverse Osmosis (RO) Membranes to Facilitate Foulant Removal

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Introduction

- Seawater desalination is an increasingly important alternative for producing fresh water.

- Seawater desalination processes are plagued by foulants, decreasing the water flux, impeding process efficiency, and shortening membrane life.

Objectives

- Explore the use of negatively charged nanoparticle (NP) coatings composed of titanium dioxide (TiO_2-PA(-)) and silver (Ag-PA(-)) on RO membranes to facilitate the removal of foulants and to regenerate the membranes.
- Effectively deposit NPs on the membrane.
- Utilize a pH soak to remove the NP coatings.

Experimental Methods

PolyDADMAC (pD), a positively charged polymer, was used as a bridge between the RO membrane (Filmtec SW30HR) and the negative nanoparticles, which are incorporated with polyacrylate polymers, to enable effective deposition on the membrane surface. Ten percent TiO_2-PA(-) and 10% Ag-PA(-) solutions, along with 0.2% pD solution, were used to coat the membranes through a self-adsorption method.

The coated membranes were run through an electrokinetic analyzer (SurPASS, Anton-Paar, Austria) to determine the surface charge, or zeta potential, of the coated membranes. Single measurements were taken at a pH between 5.50 and 5.80.

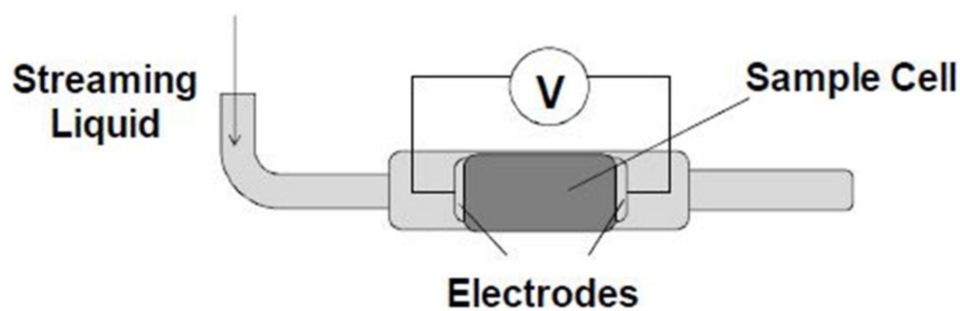

Figure 1: SurPASS streaming current measurement cell. The SurPASS calculates the zeta potential of the membrane surface by measuring the streaming current with the electrodes on both ends of the sample cell.

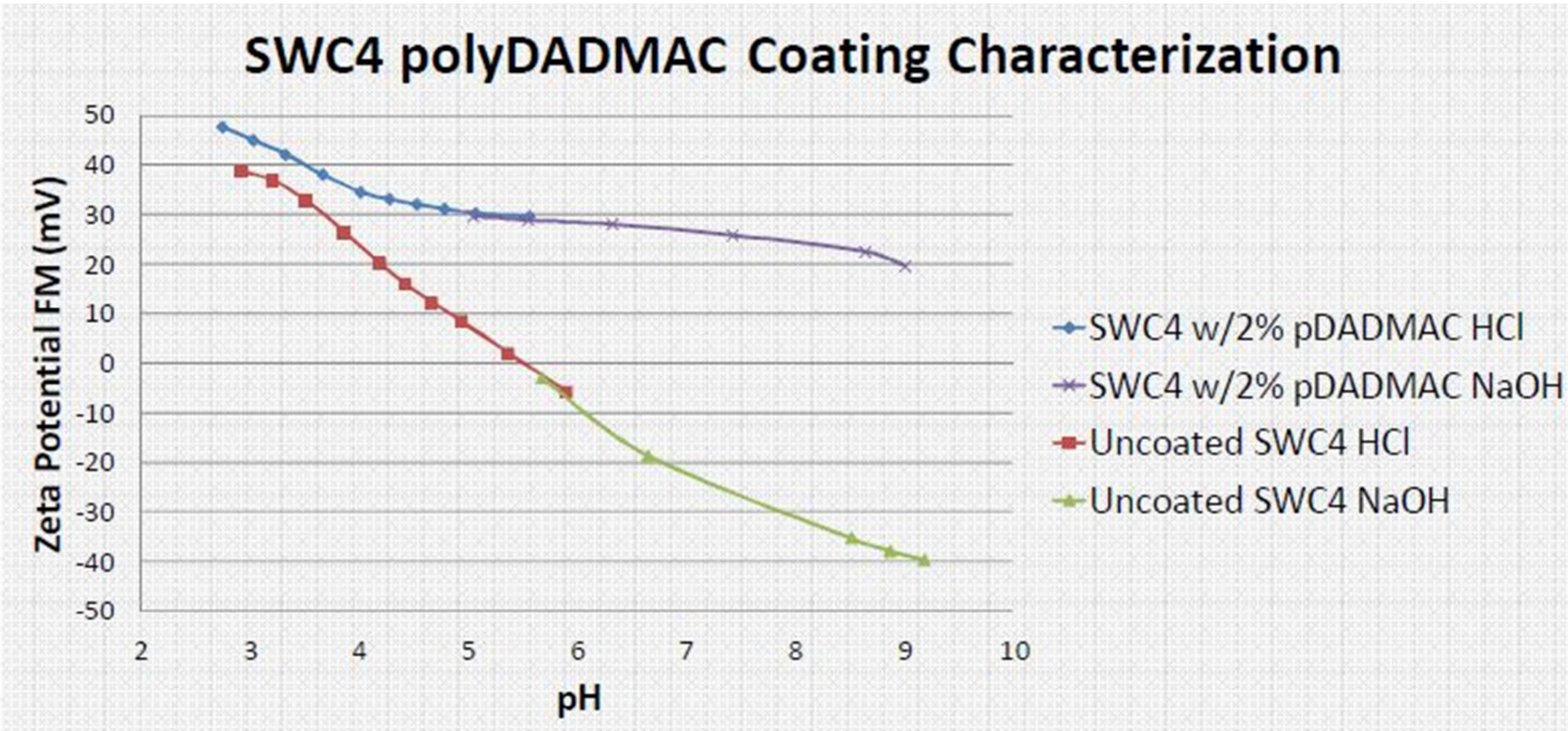

Figure 2: SurPASS titration curves for virgin and 2% pD coated SWC4 membranes (Hydranautics). The polyDADMAC coating increased the zeta potential, compared to the virgin membrane.

Experimental Methods

Nanoparticle coating removal experiments were performed by soaking the coated membranes in solutions of pHs 1, 2, and 13.

Contact angle measurements confirmed deposition. Scanning electron microscopy (SEM) confirmed membrane deposition and removal.

Results

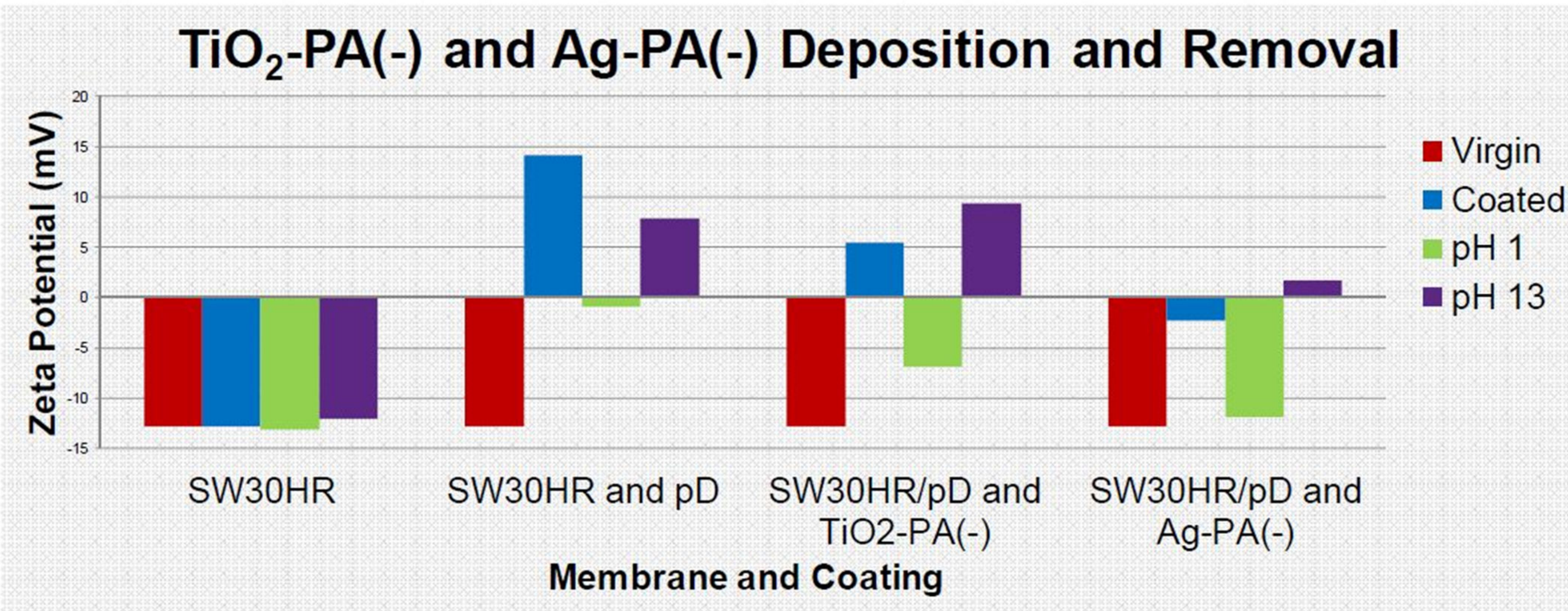

Figure 3: Zeta potential for deposition and removal procedures.

SEM Images of Silver NP Coating and Removal

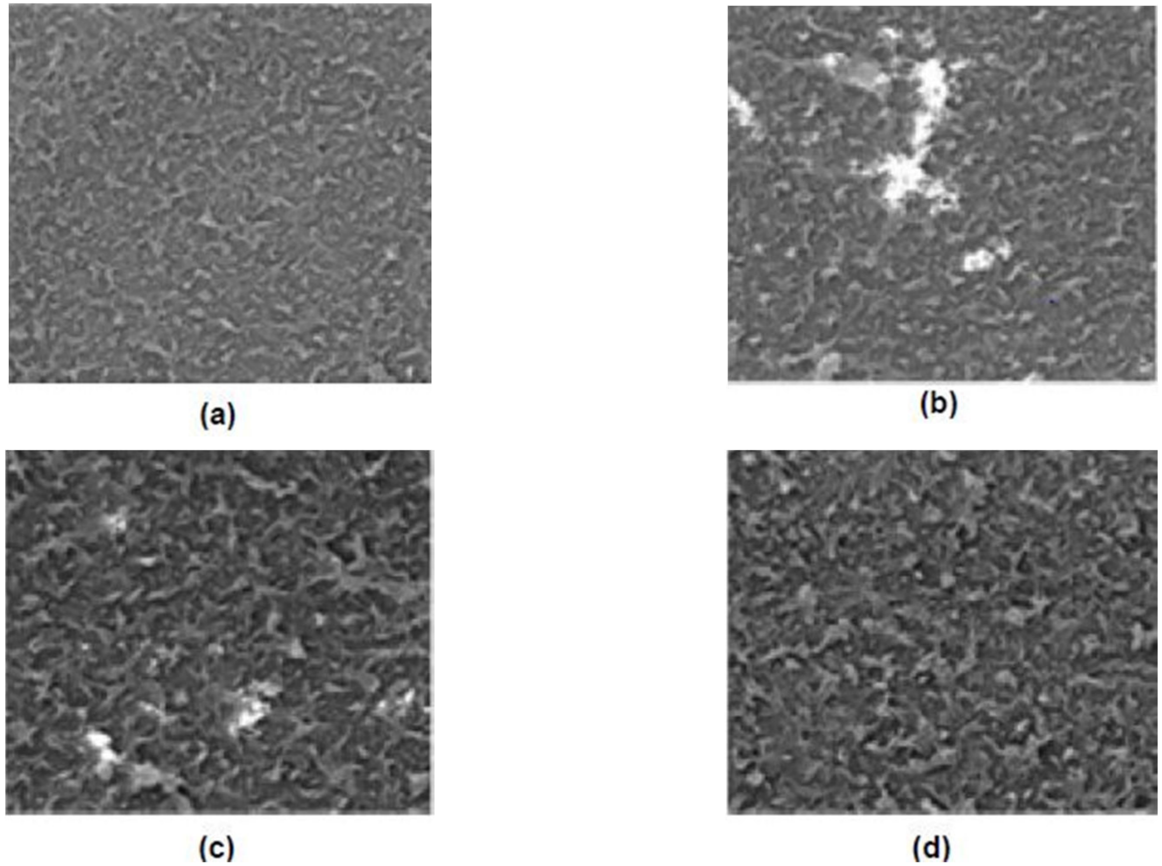

Figure 5: SEM images with magnification x10000. (a) polyDADMAC coating. (b) Ag-PA(-) coating. (c) Ag-PA(-) coating after pH 1 soak. (d) Ag-PA(-) coating after pH 13 soak.

Conclusions

- TiO_2-PA(-) and Ag-PA(-) NP coatings on SW30HR membranes can effectively be deposited through self-adsorption with a pD bridge layer.

- pH 1 and pH 13 soaks remove the NP coatings.

Future Work

- Consider the effects of each coating on water flux.
- Examine use of ionic-strength techniques to remove coating.
- Investigate the effectiveness of foulant removal via nanoparticle coating removal.
- Apply coating removal to desalination process.

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