Smart" nanomaterials for seawater desalination

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In this talk, we will present our recent work on using stimuli-responsive nanoparticles as "smart" draw solutes to desalinate seawater in forward osmosis process.

Forward Osmosis (FO, also known as direct osmosis) technology has been intensively studied for its use in desalination, water reuse, and power generation. FO process utilizes the osmotic pressure difference of two solutions separated by a semi-permeable membrane to induce spontaneous movement of water molecules from the less concentrated solution (feed solution) to the other solution (draw solution) while most solutes are rejected by the FO membrane. It has the potential to reduce energy cost for desalination compared to current technologies such as reverse osmosis that requires high-quality power to generate high hydraulic pressure. The selection of a suitable draw solute can greatly influence the efficiency of FO.

In general, entitled draw solutes in FO for water production possess the qualities of being able to generate high osmotic pressures and easy recovery of the water obtained. Magnetic nanoparticles with hydrophilic surface functionality and high surface area-to-volume ratio may generate high osmotic pressures for desalination and water reclamation purposes. Although draw solute based on magnetic nanoparticles can be regenerated using magnetic fields, high field strength is generally required. Therefore, we designed a new class of "smart" draw solute -- thermoresponsive polymer-functionalized magnetic nanoparticles. With the assistance of thermal stimuli-induced aggregation, the nanoparticle draw solute can be readily recovered without sacrificing its osmolality and hence water flux. The stimuli can be mild heat from waste energy in industrial plants or solar power to minimize energy cost. The aggregated nanoparticles can be redispersed upon removal of the stimuli so they can be regenerated for FO.

References

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Figures