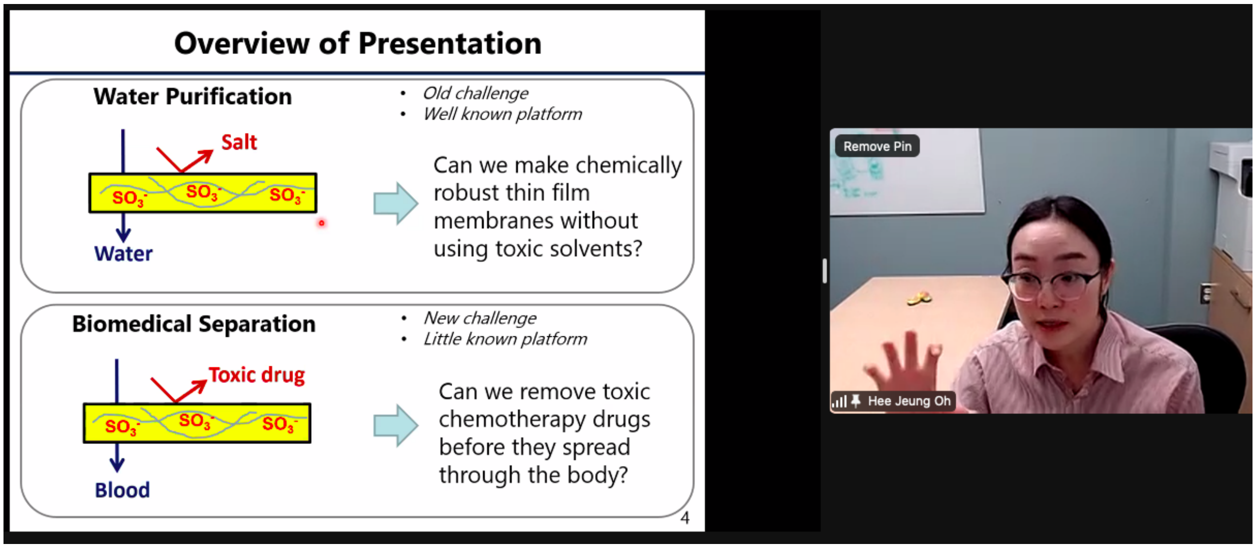
Molecular Scale Engineering of Polymer Membranes for Environment, Energy and Health

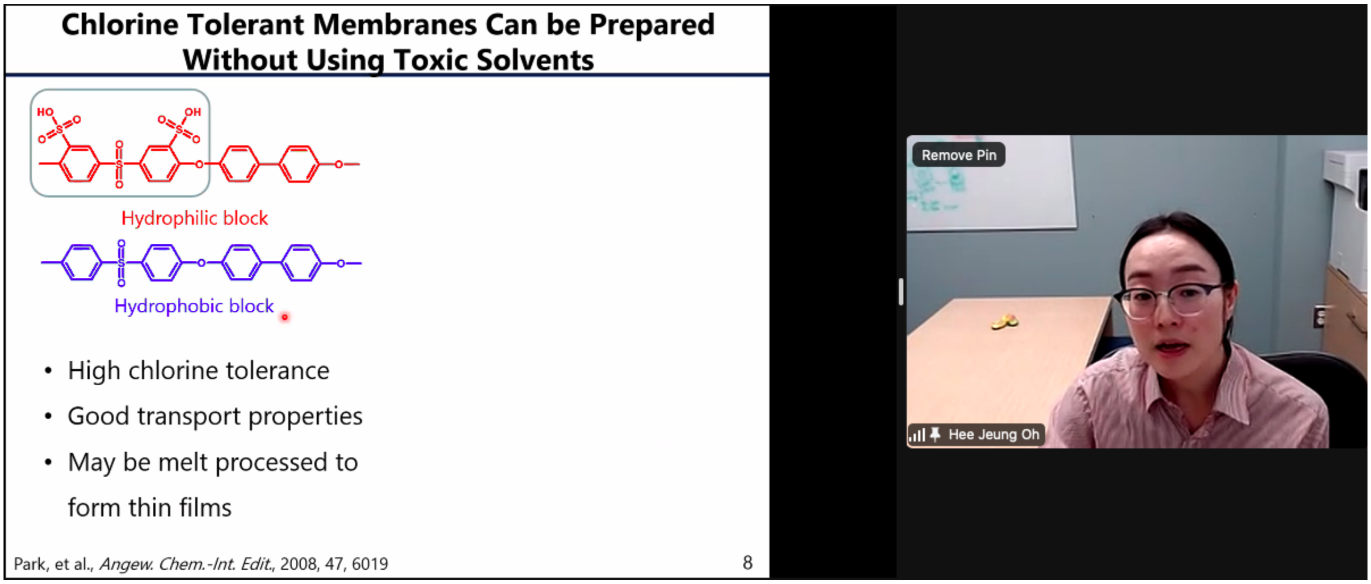
By Alex Madonik

On Thursday, March 28th, Assistant Professor Hee Jeung Oh of Penn State University presented a webinar on novel, solvent-free methods for preparing semipermeable membranes used in water purification and in selective absorption of bioactive molecules.



Professor Oh had just returned from the New Orleans National Meeting, where the ACS Polymer Chemistry and Polymeric Materials Divisions (POLY and PMSE) had just celebrated their 100th anniversary. Her presentation focused on a novel method of melt-processing semipermeable membrane materials, their characterization, and their application to water purification and selective retention of pharmaceuticals.

In her introduction, Professor Oh explained that the crosslinked polyamide films currently used for large-scale desalination of water are susceptible to degradation by chlorine, which essential for controlling bacteria in drinking water. The chlorine must be neutralized before desalination, and then added back after the filtration step, increasing the cost and complexity of the process. Sulfonated polyethersufone polymers are a chlorine resistant alternative material that can be melt-processed, without the use of potentially toxic solvents:



The difficulty is the very high glass transition temperatures for the sulfonated polymers, which require processing above 400°C. To lower the melt temperature, Professor Oh's group added varying amounts of polyethylene glycol (PEG, molecular weight 400 or 600). PEG is miscible with the sulfonated polyether sulfone material because it complexes the cations associated with the sulfonate groups. After processing into films at around 200°C, water extraction removes the PEG and leaves a membrane with increased permeability due to the expanded "free volume" between the polymer chains. Never before have such films been prepared in a solvent-free process. Professor Oh's group has continued to study the diffusion properties of these new films, showing how their permeability and selectivity depends on processing parameters.

In the second part of her talk, Professor Oh described a novel cation-exchange resin prepared as block copolymer containing both hydrophobic and hydrophilic segments. This polymer can be coated onto custom-engineered porous structures created through 3D printing, because the hydrophobic segments adsorb strongly on the surface of the polymer used in the 3D printing process. The resulting devices can be threaded onto a catheter and inserted into a vein where they can selectively absorb bioactive molecules such as the chemotherapy agent doxorubicin. The goal is to prevent excess doxorubicin from leaving the site of treatment (e.g. the liver) and entering the heart, which can be damaged by this drug. Professor Oh's group has demonstrated this device *in vivo* using pigs, and it captured approximately two thirds of the doxorubicin leaving the liver.

A lively discussion followed the talk, showing the power of Zoom to bring together scientists across borders and long distances. The talk was recorded, and the link has been posted to the Cal ACS web site. We will invite additional speakers from the ACS Speaker Directory, and we welcome your suggestions!