Membranes are at the forefront of water filtration technologies because they offer superior reliability as a physical barrier against a diverse array of pollutants. However, even minimal damage to a membrane can result in significant reduction of its rejection level, discounting one of the process’s notable advantages. In this presentation, we will present two strategies for developing smart membranes with self-healing capability that can enhance the resilience of membrane filtration processes. First, we embed microcapsules loaded with a water-reactive core within a conventional polyethersulfone membrane. When the membrane structure is physically damaged, the microcapsules release a reactive isocyanate healing agent that reacts with the surrounding water to form a polyurea matrix that plugs the damage. In the second approach, a hydrogel pore-filled membrane is fabricated. When these membranes are damaged, the differential swelling ability between free and constrained hydrogels leads to expansion of the hydrogel near the damage area, effectively sealing the damage. We suspect that molecular-interdiffusion of the hydrogel chains may play a role in fully mending the damage. The results of these proof-of-concept studies are used to elucidate opportunities and challenges in the development of smart and adaptive materials for environmental applications beyond membrane filtration.

Background

Dr. Getachew is an Assistant Professor in Environmental Engineering at Rice University. She completed her Ph.D. and M.Sc. in Chemical and Environmental Engineering at Yale University, where she developed the first autonomously self-healing water filtration membranes. She also holds a B.S. in Chemical Engineering (ABET) from Yale. Prior to joining Rice University, Dr. Getachew spent two years as a Postdoctoral Associate at the Department of Materials Science and Engineering at Massachusetts Institute of Technology. Her current research focuses on understanding the performance of “smart materials” in the context of water treatment technologies and resilient water infrastructure.