2023 McCabe Lecture

Hydrogels for Solar-Driven Water Purification

Monday,
April 10, 2023
10:30 AM
EB1 1011

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Refreshments will be served from 11:40-12:00 in EB1 2014 (Student Lounge)

Providing access to safe water is a major global challenge due to expansion of industrialization, growth of the global population, and contamination of freshwater resources. According to the United Nations, in the last century, global water requirements grew at a rate more than twice that of the population growth rate. In the United State alone, the Environmental Protection Agency has identified over 70,000 water bodies in the United States alone that are impaired by pollution. The health issues associated with consuming contaminated water are well-known: waterborne disease outbreaks, leading to gastrointestinal illness, reproductive complications, and neurological disorders, amongst others. More than 1.5 million people die each year from diarrhea caused by the intake of unsafe drinking water. Therefore, developing advanced water purification technologies that provide access to safe water to more of the global population remains an enduring challenge.

Hydrogels have emerged as promising soft materials for sustainable and off-grid water purification and harvesting. However, the low water production rate well below daily human demand is a current impediment to technology translation. To make progress towards addressing this challenge, we present work on the development of a rapid-response solar absorber gel membrane capable of producing potable water from various contaminated sources at a rate of ~ 26 kg m^{-2} h^{-1}, which is sufficient to meet daily water demand. The membrane—produced at room temperature *via* aqueous-based processing using an ethylene glycol (EG)-water mixture—uniquely integrates the attributes of poly(N-isopropyl acrylamide) (PNIPAm), polydopamine, and poly (sulfobetaine methacrylate) to enable off-grid water purification with enhanced photothermal response and the capacity to prevent oil- and bio-fouling. The use of the EG-water mixture was critical to forming the loofah-like structure with enhanced water transport. Remarkably, under various sunlight irradiations of 1 and 0.5 sun, LSAG required only 10 to 20 min to release ~ 70 % of its stored liquid water, respectively. Equally important, we demonstrate the ability of the membrane to purify water from various harmful sources, including those containing small molecules, oils, metals, and microplastics.

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