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A 3D Self-Floating Photothermal Cryogel for Solar Desalination

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This presentation highlights the fabrication of photothermal cryogels for freshwater generation via solar-driven evaporation of seawater. Photothermal cryogels were prepared via *in situ* oxidative polymerization of pyrrole on pre-formed poly(sodium acrylate) (PSA) cryogels. We found that the pyrrole concentration used in the fabrication process has a significant influence on the morphology of the resultant PSA/PPy cryogels (PPCs). PPC synthesized using the lowest pyrrole concentration (i.e., PPC10) shows the best solar-evaporation efficiency compared to the other samples, which is further improved by switching the operative mode from floating to standing. Due to the contribution of evaporation from the exposed lateral surfaces in the standing mode, the resultant apparent solar evaporation rate and solar-to-vapor conversion efficiency can reach up to 1.41 kg m^{-2} h^{-1} and 96.9%, respectively. Furthermore, the distillate obtained from condensation of the vapor, generated via solar evaporation of a synthetic seawater through the PPC10, displays at least 99.99% reduction of Na while all the other elements are reduced to sub-ppm level. The superior solar evaporation and desalination performance of PPC10 can be attributed to its: (i) higher photoabsorption efficiency, (ii) higher heat localization effect, (iii) open porous structure that enhances vapor removal, (iv) increased surface area for light absorption and water evaporation due to the presence of pores with high surface roughness, and (v) higher water-absorption capacity that ensures efficient water replenishment to the evaporative sites. We anticipate that the relationship of the structure-property-function our study would offer insightful guidelines to better designs of polymer-based 3D photothermal materials for solar evaporation as well as for other emerging solar-related applications.

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