Hydrophobic light-to-heat conversion membranes for interfacial heating: towards enhanced solar evaporation

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Water evaporation driven by solar irradiation plays a critical role in global water cycle as well as in many industrial processes. However, the conventional solar evaporation experiences high energy loss and thus low evaporation rate due to its bulk water heating nature. Aiming at enhancing solar-driven evaporation, herein, we propose and demonstrate a novel interfacial heating membrane that spontaneously stays at the water-air interface, collects and converts solar light into heat, and locally heats only the water surface. A proof-of-concept membrane is prepared by deposition of light-to-heat conversion material of polypyrrole onto porous stainless steel mesh, followed by hydrophobic modification. Our results confirm that with the membrane floating on water surface, a sharp local temperature gradient is generated on the water surface, leading to significant water evaporation rate. The study also extends the interfacial heating membrane into solar water distillation and contributes a solar-driven point-of-use device for freshwater production.