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Superhydrophilic MXene/mixed-dimensional clay/polyvinyl alcohol film for solar interfacial evaporation

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ABSTRACT

For the practical application of green and sustainable Solar Steam Generation Technology, improving solar energy conversion efficiency and salt resistance is particularly important. In this study, the MXene/mixed-dimensional clay/polyvinyl alcohol (MXene/MD-clay/PVA) film was prepared by "salt-assisted" freeze-drying method using (3-aminopropyl)triethoxysilane (KH550) modified mixed-dimensional clay (MD-clay) as the raw material, self-assembled MD-clay and MXene material, and polyvinyl alcohol (PVA) as base film. The film can effectively convert light energy into heat energy under solar irradiation, and has excellent properties such as high photothermal conversion efficiency, super hydrophilicity, and low thermal conductivity. The MXene/MD-clay/PVA film has a low thermal conductivity (0.24056 $W \cdot m^{-1} \cdot K^{-1}$); a strain at break of 7.8% at a tensile strength of 0.7 kPa; a light absorption of about 91%; and a complete infiltration of water droplets on the surface of the rGO/MD-clay/PVA film in only 0.133 s. The prepared MXene/MD-clay/PVA can be used in a wide range of applications at 1 $kW \cdot m^{-2}$. The evaporation rate of the prepared MXene/MD-clay/PVA evaporator was 1.6026 $kg \cdot m^{-2} \cdot h^{-1}$ at 1 $kW \cdot m^{-2}$, with an energy conversion efficiency of 91.7%. The evaporation rate in a 15% NaCl solution was 1.4904 $kg \cdot m^{-2} \cdot h^{-1}$, while the MXene/MD-clay/PVA evaporator provided good purification performance for the organic dye Methylene blue solution.

Keywords: Mixed-dimensional clay; Superhydrophilic film; Salt-resistant; Solar steam generation

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