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SOLAR-DRIVEN WATER PURIFICATION: ADVANCING PVA-CHITOSAN/PANI HYDROGEL TO ENHANCE SOLAR VAPOR GENERATION FOR FRESHWATER TREATMENT

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Abstract
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Abstract

Water scarcity is a global issue that affects human beings' ability to live healthily, and immediate action must be taken to alleviate this issue. Despite advances in water purification, current technologies exhibit pronounced deficiencies. Existing filtration systems and other conventional methods remain energy-intensive, with escalating maintenance costs at large-scale production. The advancement of innovative materials holds significant potential to revolutionize the landscape of solar water purification. While conventional solar vapor generation (SVG) technology has faced challenges in achieving high water yields under natural sunlight conditions, innovating new materials can substantially reduce the energy requirements for water vaporization. Herein, we introduce our outstanding light-absorbing hydrogel consisting of polyvinyl alcohol (PVA) and chitosan (CS) as the substrate with the addition of polyaniline (PANi) as the light absorber for water evaporation via SVG technique. In this study, PVA-CS/PANi hydrogels were prepared with distinct concentrations of PVA and denoted as PVA-CS/PANi/1.3 mol.%, PVA-CS/PANi/2.7 mol.% and PVA-CS/PANi/3.9 mol.%. Copolymerization of PVA-CS hydrogels with PANi was conducted via solution polymerization to incorporate PANi into the hydrogel network structure. Incorporating light-absorbing materials, such as PANi, into the hydrogel network structure is expected to enhance the absorption properties. The morphological structure of the obtained hydrogels was analyzed by scanning electron microscopy (SEM). In contrast,

the physicochemical and mechanical properties of the hydrogels were evaluated by dynamic light scattering (DLS), FTIR, swelling test and rheology. From the analysis demonstrated in this work, the structure of PVA-CS/PANi hydrogels is significantly influenced by the concentration of PVA. The hydrogels' diameter and polydispersity index (PDI) were 146 nm and 0.331, respectively. The storage modulus (G') of PVA-CS/PANi/3.9 mol.% depicted the highest value of 2356 Pa compared to PVA-PVA-CS/PANi/1.3 mol.%, which depicted the G' value of 1173 Pa. From FTIR analysis, the absorption band was found between 3600 to 3000 cm-1, attributed to O-H and N-H groups of PVA and PANi, while the PVA-CS with the presence of PANi shows characteristic bands at 1620 cm^{-1}, 1508 cm^{-1}, and 1298 cm^{-1}. The microporous structure of PVA-Chitosan/PANi hydrogels increases with a higher concentration of PVA, demonstrating the degree of cross-linking of PANi, which contributes to the rigid structure of porous hydrogel. The influence of PVA concentration on the hydrogel's porous structure and surface area allows for greater dye adsorption. As demonstrated by PVA-CS/PANi/3.9 mol.%, it shows higher absorption of Methylene Blue (MB) into the structure. The performance of SVG using PVA-CS/PANi/3.9 mol.% hydrogels was measured, and the efficiency was found to be 69.8% under 1 sun with efficient temperature distribution on the surface. This finding indicates the capability of PVA-Chitosan/PANi/3.9 mol.% hydrogels in generating multi-scattering effects of natural sunlight for high-efficiency light-to-heat conversion via SVG.

Author keywords

Hydrogel; polyaniline; polymer colloids; solar vapor generation

SciVal Topics

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