Solar-Thermal Evaporation and Induced Power Generation Performance of Graphene-Based Devices

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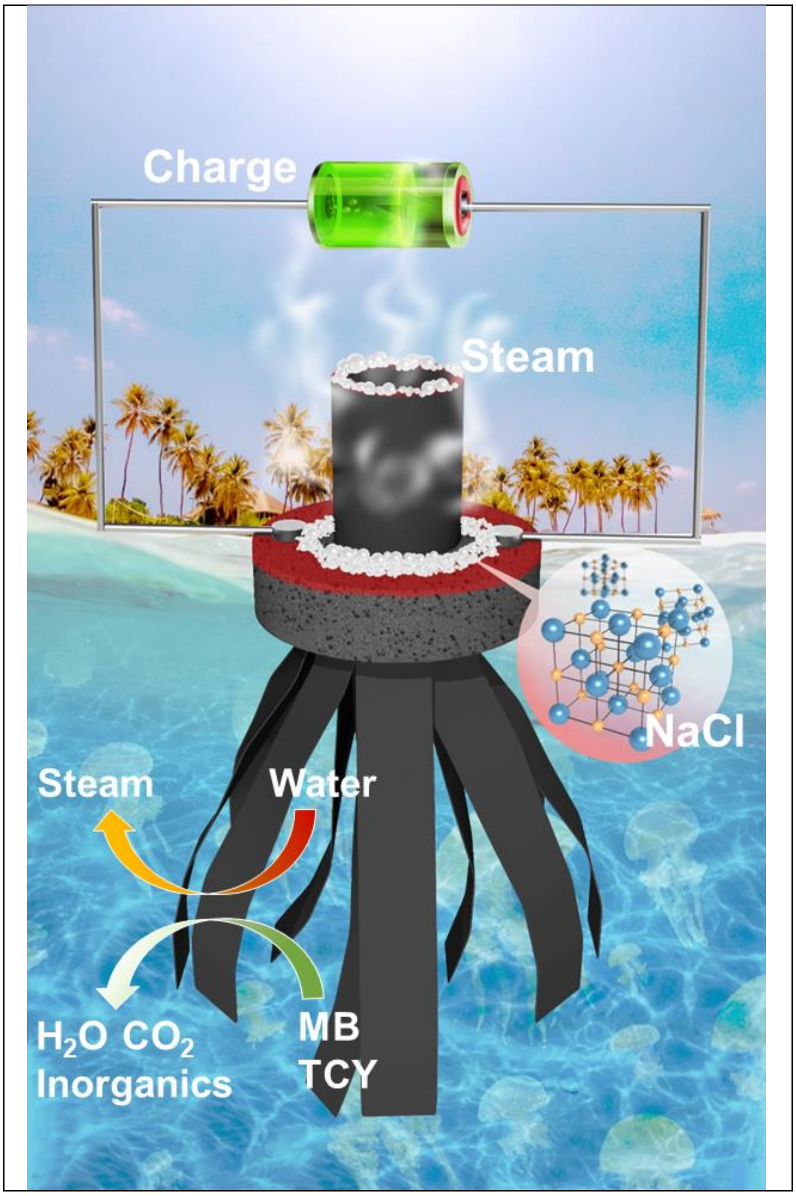
With the increasing population and serious water pollution, the global issues of fossil energy crisis and water scarcity have become one of the most severe challenges faced by human society. Solar-driven interfacial photothermal evaporation, which converts solar energy into thermal energy by photo-thermal conversion materials, is considered a promising technology for efficient freshwater acquisition. Compared with traditional solar evaporation techniques that heat the entire body of water, interfacial solar photothermal evaporation utilizes solar energy more efficiently, as thermal evaporation only occurs at the air-water interface, significantly reducing the conduction heat losses and improving the solar-to-vapor conversion efficiency of the system. Currently, a large amount of research is dedicated to modulating the physicochemical properties of photothermal materials and designing efficient interfacial evaporation systems. However, the low energy utilization efficiency and freshwater production rate in integrated seawater desalination devices remain challenges for solar evaporation technologies. To address these issues, researchers aim to select appropriate photothermal materials and optimize the evaporator structure to enhance solar energy utilization efficiency, meeting the demand for clean water supply. Moreover, by integrating power generation functions into solar photothermal evaporation systems, the solar-mixed system can serve a dual purpose of freshwater production and electricity generation, enabling the system to operate continuously day and night and improving overall energy conversion efficiency. This presentation focuses on two main themes: energy acquisition and conversion, and resource recovery and utilization. Graphene-based materials and their composites are used as photo-thermal materials to design solar-thermal devices for maximizing energy and resource utilization. The key scientific and technical problems of solar evaporation system, such as light absorption, heat loss, water collection and latent heat utilization, are emphatically solved. The combination of water evaporation-induced power generation technology with solar-thermal evaporation technology was proposed, enriching the application field of solar photothermal evaporation technology and maximizing resource utilization.



Pic.1 Multifunctional integrated 3D asymmetric nanofluid solar photothermal evaporator for seawater desalination, salt collection, power generation, and photocatalytic degradation