All-ceramic solar-driven water purifier based on anodized aluminum oxide and plasmonic titanium nitride

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Titanium nitride (TiN) nanoparticles (NPs) act as excellent solar-heat nano-generators due to their broadband plasmonic resonances together with their chemical stability. So far, TiN NPs have been studied without loaded onto any host or support materials for solar water distillation system, which make them difficult to re-use in practical applications [1]. To overcome this drawback, our previous studies have demonstrated a floating composite structure composed of TiN NPs and transparent ceramic fibers with improved solar steam generation efficiency upto 80% [2]. In the current project with the motive to further enhance the solar steam generation efficiency, we develop cost-effective, reusable and efficient composite ceramic structures using porous alumina.

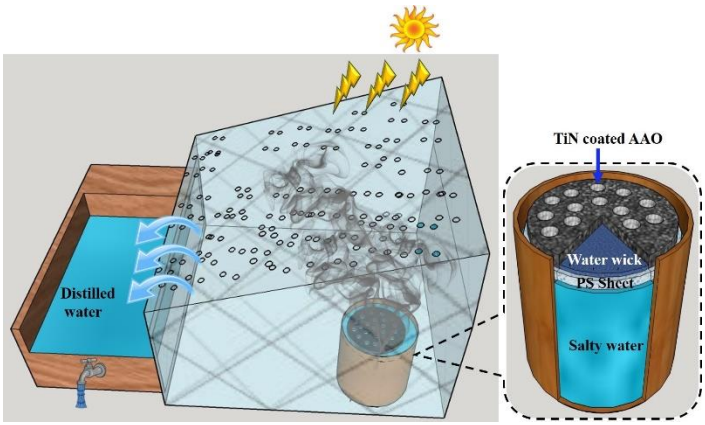

Figure: Schematic shows Titanium nitride (TiN) coated anodized aluminum oxide (AAO) converts the incident solar energy into thermal energy by the photothermal conversion and generate steam efficiently.

Here, we demonstrate an efficient method of water purification and desalination using anodized aluminum oxide (AAO) with titanium nitride (TiN). While the ceramic TiN converts the incident light energy into thermal energy and generates a hot region at the water-vapor interface, AAO provides the efficient transport of water to the forefront of water evaporation through its nanochannel. Our studies have shown that photothermal performance of TiN-AAO can be optimized by adjusting the pore diameter and TiN thickness. Additionally, a thermal insulation by a facile technique was effective in improving the water evaporation speed. Low cost and concise design makes our structure portable material for the solar steam generation. It has 95% steam generation efficiency under solar irradiation of 100 mW cm^{-2}.

[1] S. Ishii, R. P. Sugavaneshwar, T. Nagao, The Journal of Physical Chemistry C 2015.

[2] M. Kaur, S. Ishii, S. L. Shinde, T. Nagao, ACS Sustainable Chemistry & Engineering 2017, 5, 8523.