

### **3D spacer fabric structured airflow channel for enhanced solar desalination with efficient multi-energy harvesting**

#### **Abstract**

Solar steam generation (SSG) is a sustainable way to drive seawater desalination and wastewater purification with green environmental energies including solar radiation, ambient heat, and airflow. Airflow is ubiquitous in outdoor environments, however, the utilization of airflow for accelerated evaporation through structure engineering remains unclear. Herein, environmental energies are efficiently utilized in an integrated way with the rational design of 3D spacer fabric. Carbon fiber bundles with broadband photothermal conversion ability and Tencel yarns with superior hydrophilicity are fabricated into the 3D spacer fabric. The stereoscopic airflow channel, wide evaporation surface area, and separated layers are constructed to optimize airflow pathways. Heat loss is reduced through the accelerated evaporation cooling effect. Extra ambient heat is harvested for cold evaporation by efficient airflow utilization. The evaporation rate of 3D spacer fabric reaches  $5.15 \text{ kg}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$  under a convective airflow of  $3.5 \text{ m}\cdot\text{s}^{-1}$ , which is twice the rate of traditional plain fabrics. The outstanding salt resistance is realized due to the separate design of photothermal and water supply layers as well as the continuous water circulation. The structural engineering of condenser devices is also investigated for enhanced airflow utilization. Overall, this work presents an effective and comprehensive multi-energy harvesting strategy to achieve rapid and durable SSG for practical clean water production.

#### **Keywords**

Airflow; Carbon fiber bundle; Desalination; Energy harvest; Photothermal conversion