IARIA SENSORDEVICES 2022

The removal of particulate matters (PM) using solar-driven steam flow

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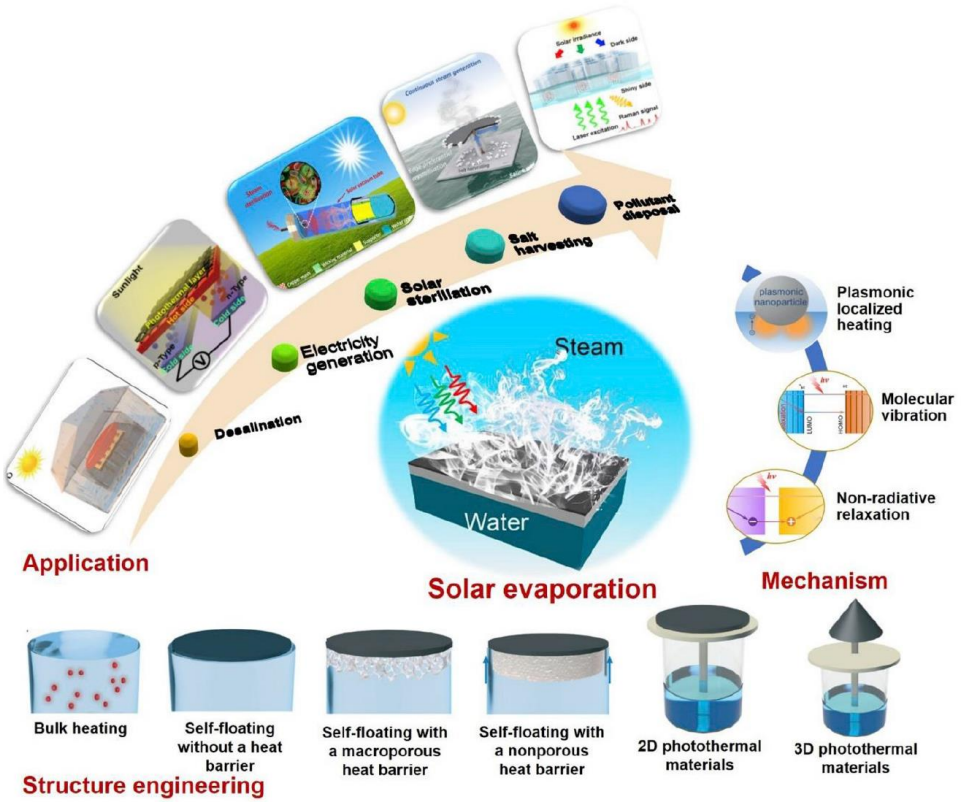
Introduction

Solar steam generation



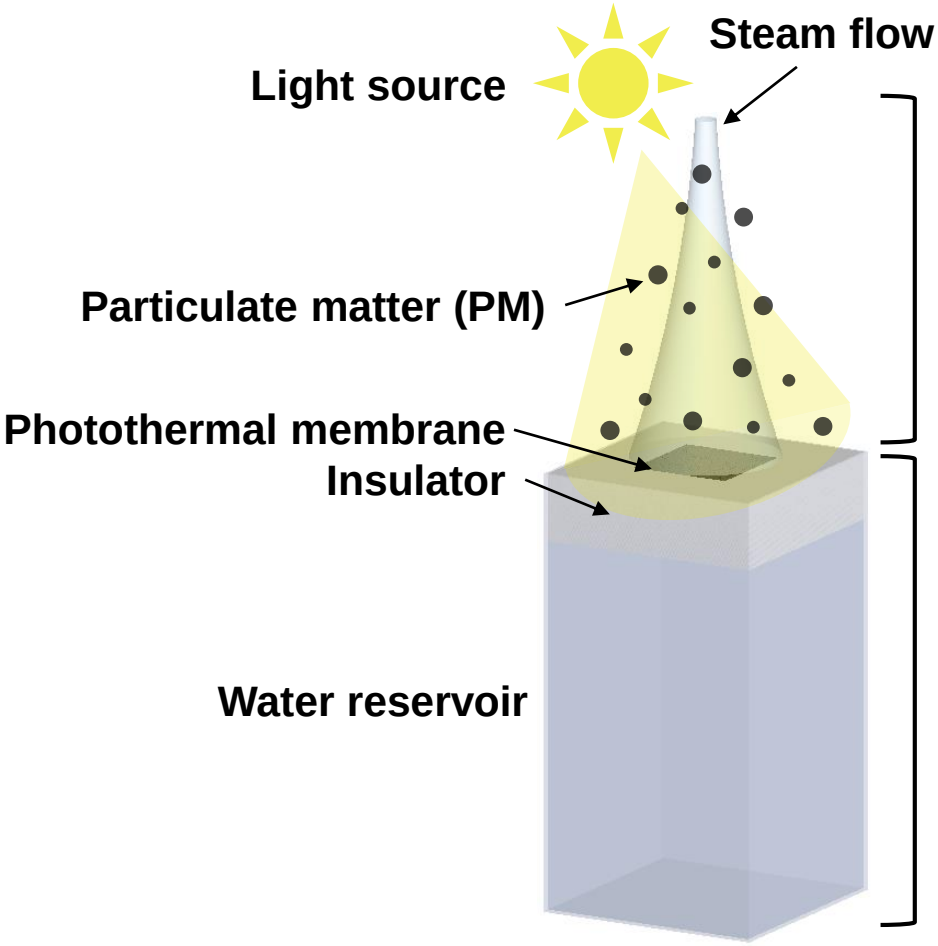
Objectives

- Quantitative analysis of steam flow

- PM removal effi. and removal mechanism

Research schematic

- Schematic of PM scavenging using a photothermal evaporator

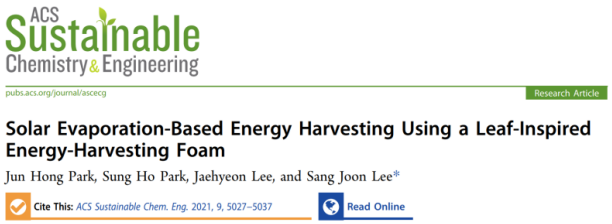


Effective PM capture
- PM capture using water droplets with flow

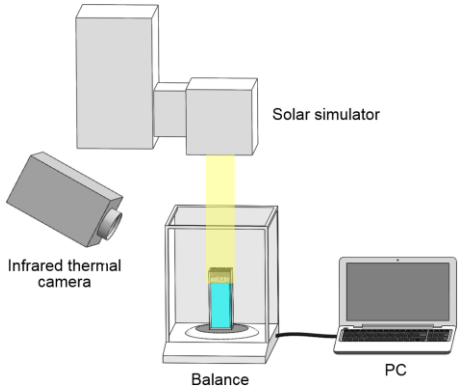
Photothermal evaporator
- Photo-thermal energy conversion
- Steam flow generation

Experimental setup

- **Evaporation and temperature measurement**



Photothermal evaporator



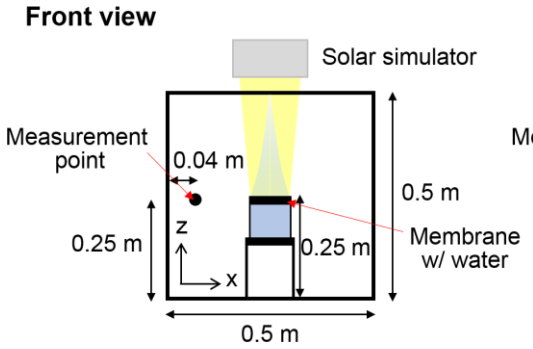
- **PM concentration measurement**

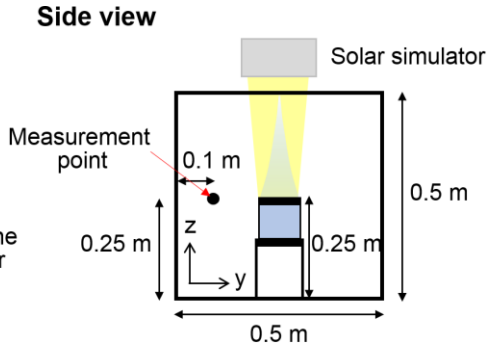
Test particles

Burning incense

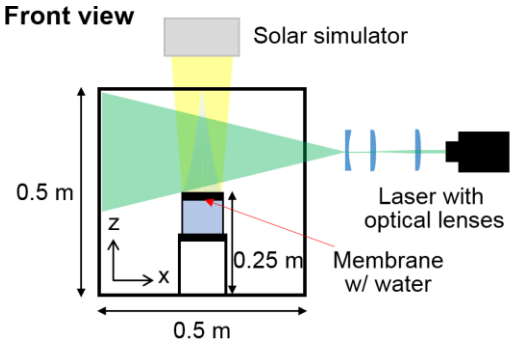
PM sensor

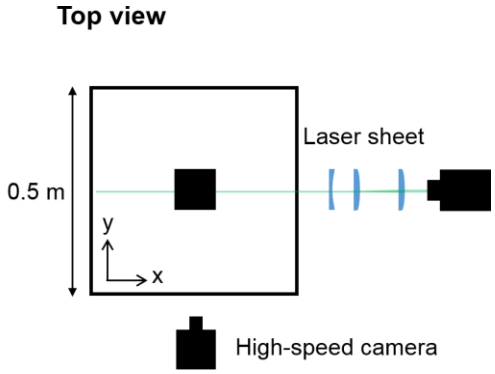
Mass concentration (μg/m^3)



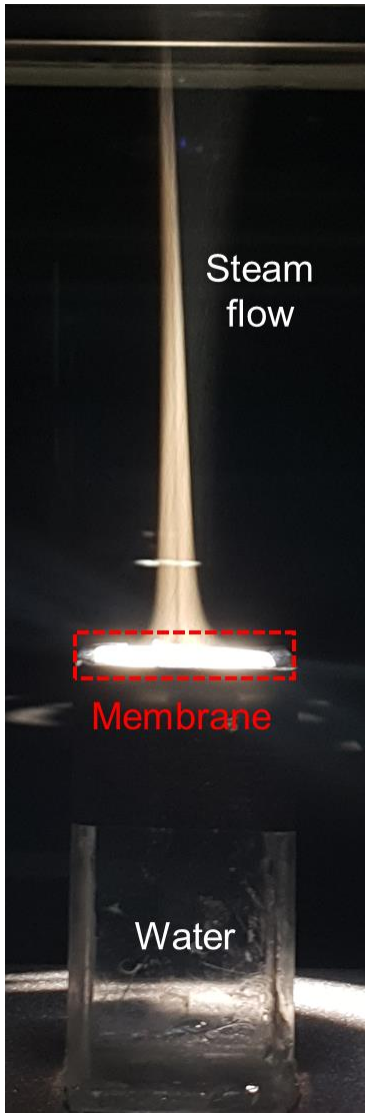


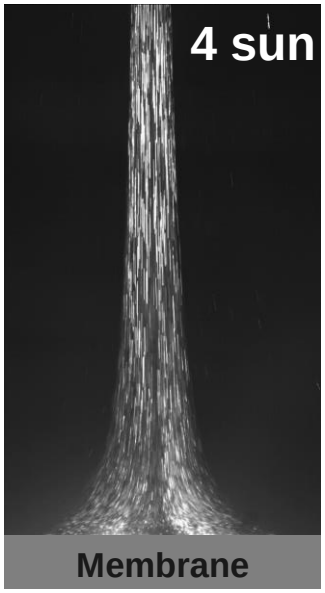
- **Visualization and PIV analysis**
  - Multigrid interrogation window
  - 32 x 32 pixels with 50 % overlap





Results (2)



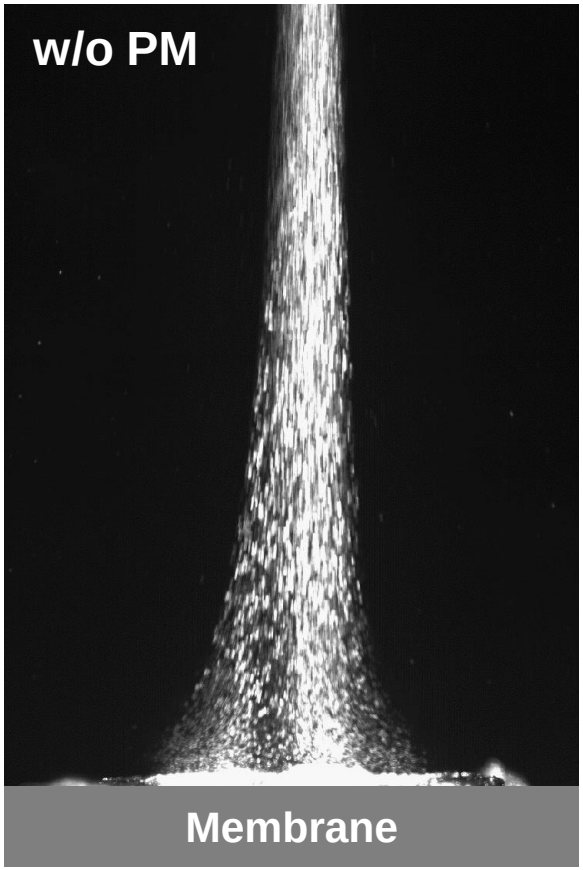


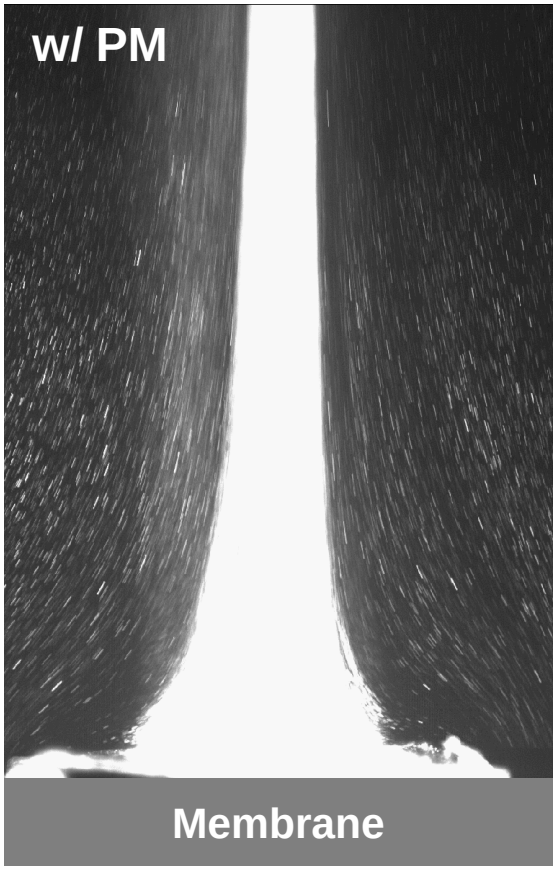
- **Steam flow visualization above the membrane**

- **Experimental condition**
  - **Light source : solar simulator (focused)**
  - **Flow visualization using high-speed camera; 250fps**
  - **PIV analysis; 1000fps**

- **The size and velocity of steam flow increases as sun intensity increases**

Results (2)

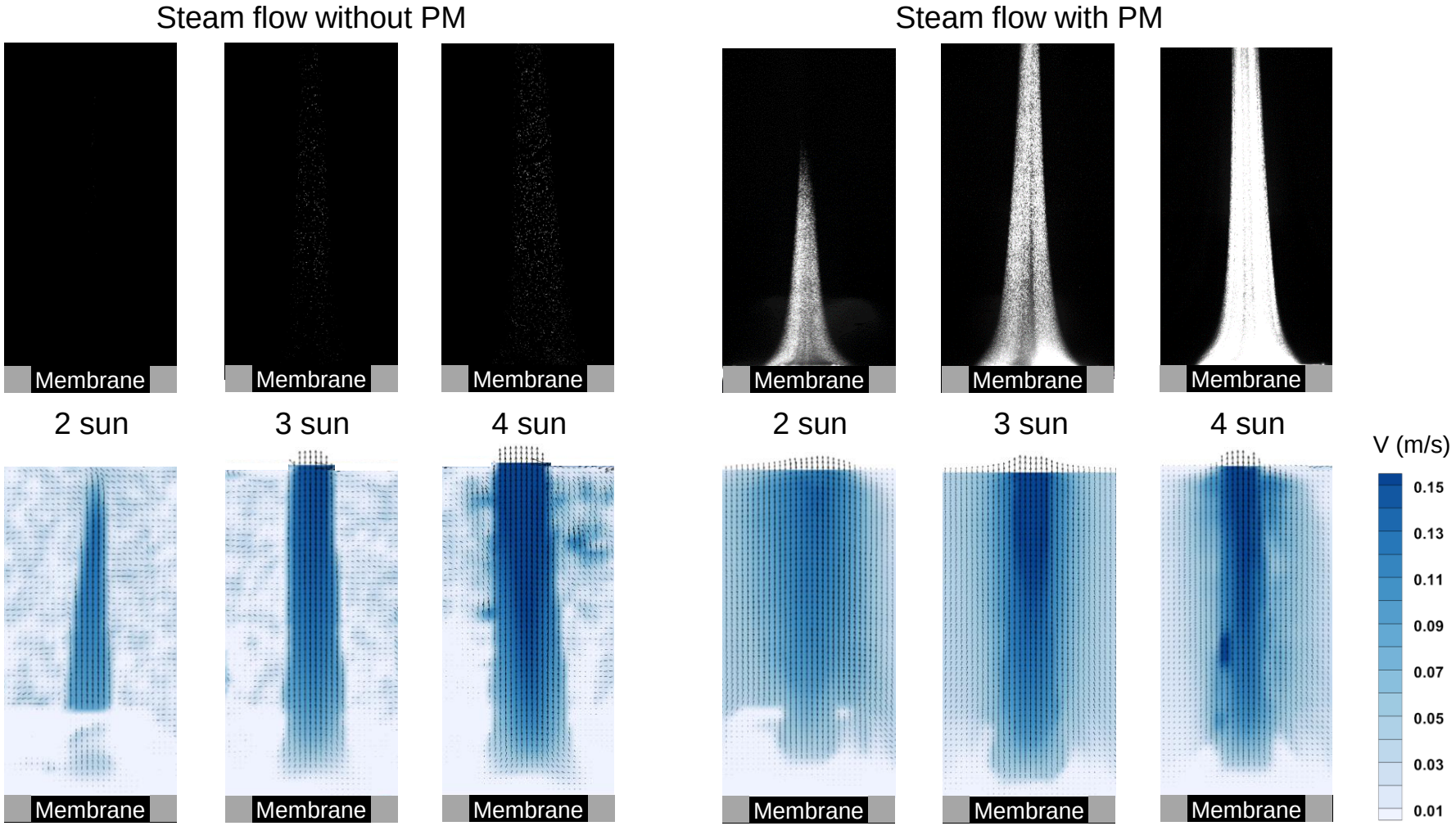




- Intensity difference is observed due to the presence of PM
- Movement of PM is influenced by the steam flow
- The closer to the steam flow, the higher velocity of PM

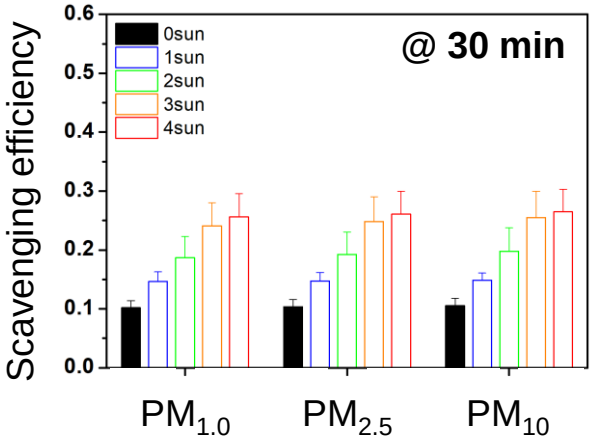
Results (2)

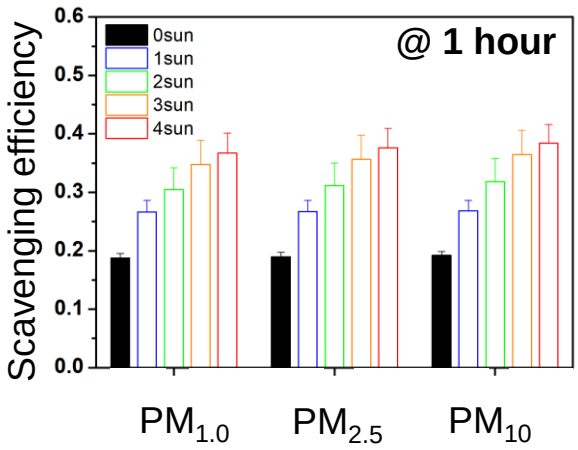
- **Grayscale images and velocity field using PIV analysis**

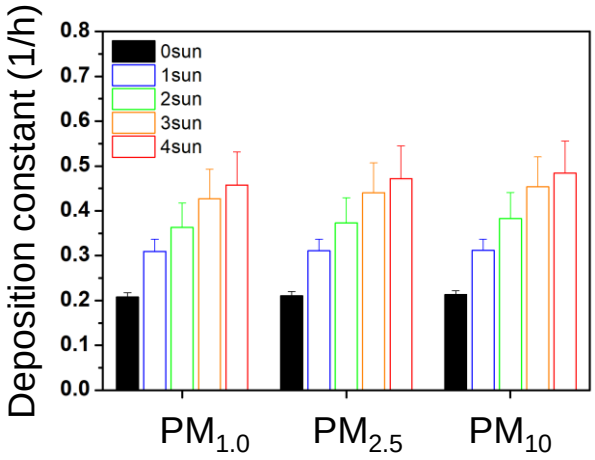


Results (3)

- **PM scavenging (removal) efficiency and deposition constant**







- **Scavenging efficiency :** $\eta = 1 - (\frac{C(t)}{C_i})$
- **Deposition constant :** $\lambda = -\frac{1}{t}\ ln(\frac{C(t)}{C_i})$
- **Under 4 sun intensity, the deposition constants of the $PM_{1.0}$, $PM_{2.5}$, and PM_{10} were 0.458 h^{-1}, 0.472 h^{-1}, and 0.484 h^{-1}, which is 2.20, 2.24, and 2.27 times higher than those of the control case without solar irradiation, respectively.**