Water Desalination Using Plasmonic Membrane

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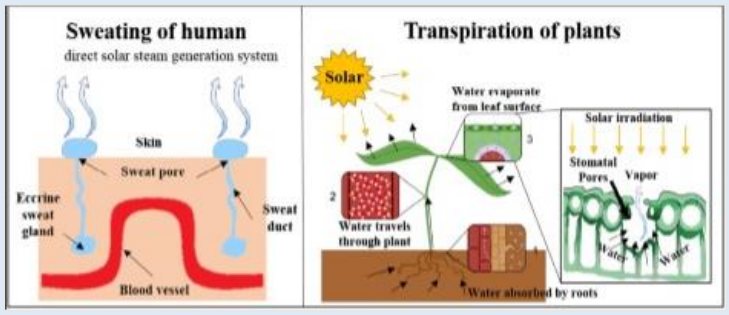
INTRODUCTION

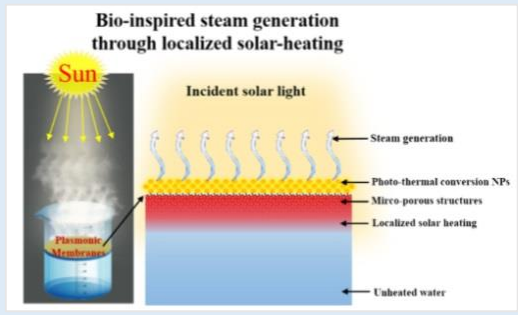
Many countries have been suffering from water scarcity while others face lack of fresh water since it represents less than 3% of worldwide water resources. Thus, this project is dedicated to use solar water desalination technology with the goal of improving its' productivity by enhancing the evaporation rate efficiency with maintaining low cost accessibility and environmental safety. The designed membrane would work as photothermal energy absorber with minimum heat losses by using Graphene-Oxide as the absorber layer, and natural wood as the micro-porous support and insulating material.

OBJECTIVES

1- To enhance the productivity of solar water desalination using Nano-particles in localized heating.
2- To increase the evaporation rate efficiency by improving the optical absorption of the plasmonic absorber.
3- To implement the designed membrane in a solar still device, built with optimized properties for best performance.

THEORETICAL BACKGROUND





Recently, direct absorption solar energy collectors were discovered. It works by preparing special structured nanometer-sized particles of metals, oxides, and carbides suspended in a fluid base called (Nano fluids). A very common application is the use of nanofluids to enhance the evaporation rates. The idea was inspired from biological systems. The evaporation efficiency in these systems is affected by the localized heating concept and the capillary flow in porous structures. Localized heating is increasing the temperature in specific regions barring others. For water evaporation, the need is to increase the temperature of the air-water interface excepting the bulk water. This is done using special manufactured membranes consisting of two layers: A solar energy collector layer, and a micro porous water transporting layer. Graphene-Oxide was selected to prepare the photothermal energy absorber for its' excellent thermo-physical properties, while natural wood was used as the micro-porous structure as it works as a thermal insulator as well as it traps the photothermal heat at the top surface and promotes the effective transport of water from the bulk to the photothermally active space.

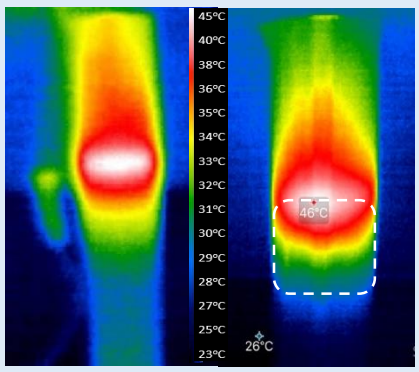
RESULTS & DISCUSSION

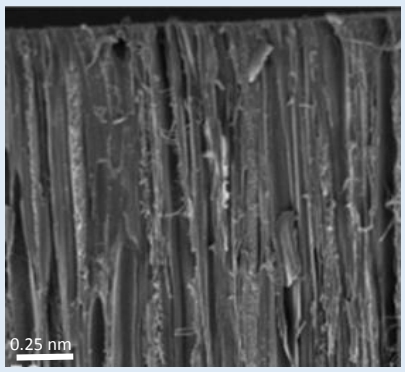
the evaporation rate efficiency have been calculated for each sample using the equation:

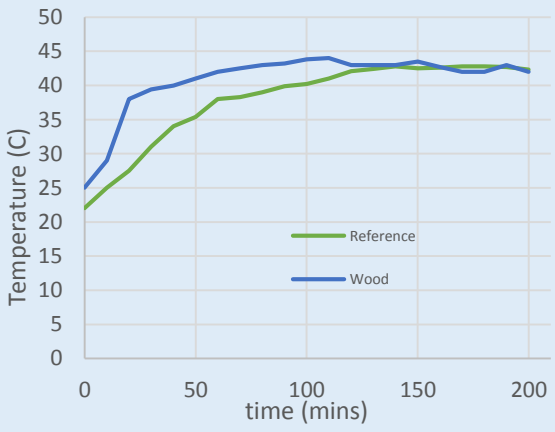
$$\eta = \frac{\dot{m} \cdot h_{LV}}{I}$$

Capillary Force

The low thermal conductivity of the wood reduced the heat dissipation from the top layer to bulk water which maintained at the room temperature. The SEM image shows the micro-channels of wood, the avenue provided for rapid and efficient water transport, which is essential for continuous operation. All of these caused the temperature of the top to increase and evaporation to occur at higher efficiency.

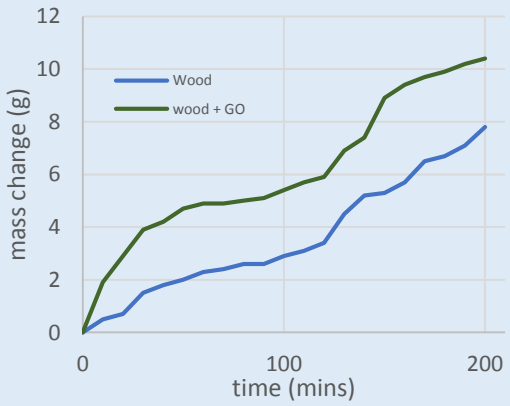




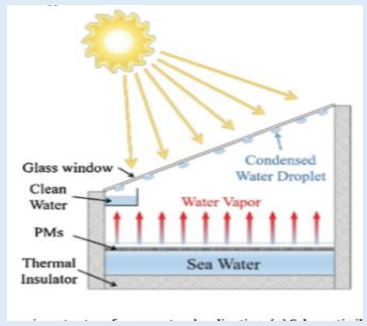


Plasmonic Nano-Particles

The temperature of wood-GO rapidly increased from room temperature to around 46°C causing significant difference in the mass of water, while it was in a slower rate using wood only. These results demonstrate the excellent photothermal capabilities of wood-GO composite due to the high optical absorption and effective photothermal conversion efficiency of GO.



Sample	Efficiency (%)
Reference (water only)	26.55
Wood	30.97
Wood + GO	52.21



Conclusion

To conclude, wood increased the evaporation rate significantly and acted as a thermal insulator that traps the photothermal energy at the upper surface, promoting the effective transport of water. Coating the wood with GO layer improved the optical absorption and increased the photo-thermal conversion which lead to a faster increase in the surface temperature compared to the bulk water. Efficiency achieved was 52.21%. A simple Application of solar-water desalination using plasmonic membrane, would be by the basic design of solar still as the one was built here.

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