A MODIFIED SURFACE FOR CONDENSATION

IITM Technology Available for Licensing

Problem Statement

- Heat transfer plays a crucial role in heating and air conditioning industries. **Phase change significantly enhances heat transfer** due to the large latent heat involved.
- Researchers have demonstrated that surface engineering at **micro- and nano-scales can improve phase change heat transfer across surfaces.**
- The present invention aims to develop a method for creating a modified surface to **achieve energy-efficient condensation.**
- The method also seeks to **improve sensible heat transfer.**
- The problem is to find an effective and practical approach to enhance heat transfer during condensation processes, benefiting energy applications in heating and cooling systems.

Technology Category/ Market

Category - Surface Modification & Condensation
Applications - Improves heat transfer efficiency of heat exchanger coils for heating, air conditioning and used for condensation and water collection for atmospheric water generators.
Industry - HVAC (Heating, Ventilation, and Air Conditioning), Renewable Energy, Dehumidifiers, Desalination and Water Treatment

Market - The global surface treatment chemicals market size is valued at 6.5 billion in 2022 and is predicted to reach 12.98 billion in the year 2031 at an **8.9% CAGR** during 2023 - 2031.

Key Features / Value Proposition

1. Enhanced Condensation Efficiency
2. Tailored Hydrophobic-Hydrophilic Patterns
3. Improved Heat Transfer
4. Scalability and Cost-Effectiveness
5. Water Sustainability and Resourcefulness
6. Energy Efficiency
7. Environmentally Friendly

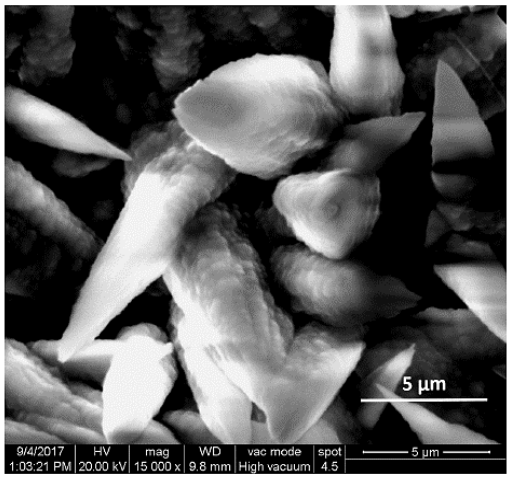

FIG.1. SEM image of the aluminium fin surface, on which hierarchical micro-nanostructures were created by mild etching process.

Intellectual Property

- IITM IDF Ref. **1610**
- **IN 201741039127**
- **PCT/IN2019/050078 - Published**
- **US11536520 - Patent Granted**

Technology

- The present invention relates to a method of creating a **modified surface for condensation** by enhancing heat transfer of metallic surfaces by
- **(1) fabricating hierarchical micro-nanostructured surfaces using etching processes, and**
- **(2) fabricating hydrophobic and hydrophilic regions, using a printing or a coating technique, followed by etching.** (Fig.3 &4)
- The hierarchical structures comprise of micron-cones of height ranging from 10-20 µm, covered with nanoscale bumps of nearly 500 nm height. (Fig.1)
- Creating such **patterns localizes micro-nanostructures to specific regions** enhancing the departure rate of condensed droplets from the surface and **improving overall water collection rate.**
- **The test setup design** was same as the atmospheric water generator design, shown in Fig. 2.

TRL (Technology Readiness Level)

TRL - 4, Technology validated in lab.

Research Lab

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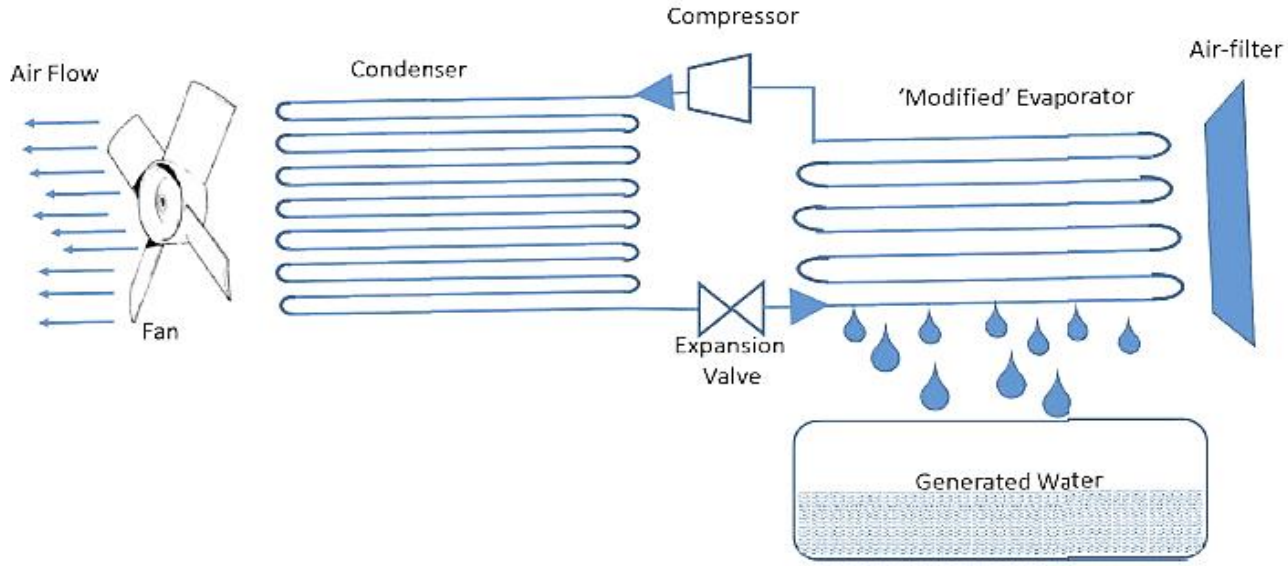

FIG. 2. Schematic of an atmospheric water generator.
Ambient air enters the system by passing through an air-filter (extreme right) and then passes across the 'modified' evaporator having fins with hierarchical micro-nanostructures, over which condensation takes place. Cold air after the evaporator then passes across the hot condenser and leaves the system thereafter.

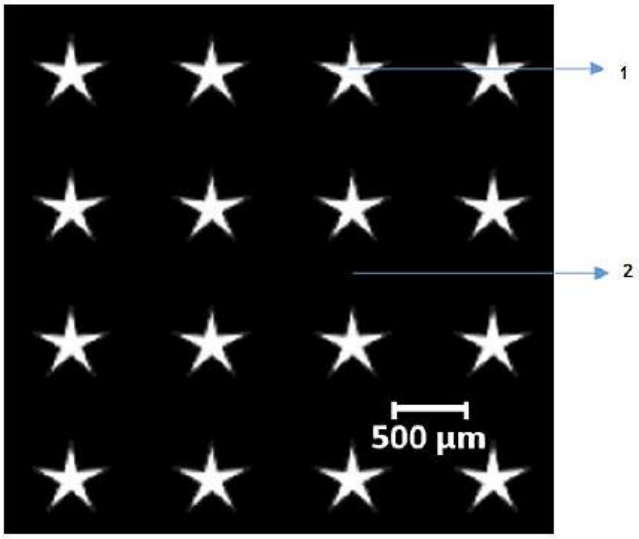

FIG. 3. Schematic representation of a hydrophobic-hydrophilic patterned metal surface using screen printing followed by etching.
The black region is a screen-printed etch-resistant hydrophobic coating (2) Etching performed after printing renders star-shaped regions hydrophilic due to creation of hierarchical micro-nanostructures (1) and the remaining un-etched region hydrophobic.

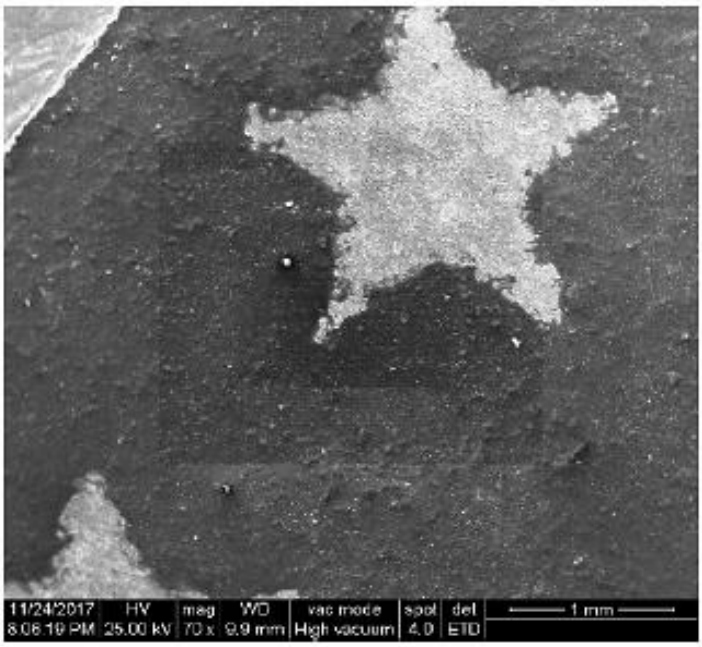

FIG. 4. SEM image of hydrophobic-hydrophilic patterned surface with micro-nano structures.

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