PATTERNED METALLIC NANOBRUSHES FOR CAPTURE OF ATMOSPHERIC HUMIDITY

IITM Technology Available for Licensing

Problem Statement

- Major Indian cities have recently faced **acute water shortages disrupting lives** and risking lives of vulnerable sections of the society.
- Water scarcity **threatens to displace over 700 million** people across the world by 2030.
- **Capture of fresh water** from rivers and lakes will not be sufficient to cater to the **rising demand** for drinking water.
- **Nature exhibits fascinating ways of water capture** by organisms such as Stenocara beetles living in the arid Namib desert.
- There is a **need for method of water capture that condenses atmospheric humidity** while mimicking similar processes found in nature.

Intellectual Property

- IITM IDF Ref. **1492**
- **IN 375956 - Patent Granted**
- **PCT :**
  - **PCT Application No: PCT/IN2017/050621**
  - **PCT Publication No: WO/2018/122872**

TRL (Technology Readiness Level)

TRL 5- Technology Validated in Relevant environment

Technology Category/ Market

Category-Environmental Engineering
Industry Classification:

- **NIC (2008)- 3600-** Water collection, treatment and supply**; 42204-** Construction and maintenance of water main and line connection, water reservoirs including irrigation system, **28192-** Manufacture of air-conditioning machines
- **NAICS (2022)- 22131-** Water Supply and Irrigation Systems**; 23711-** Water and Sewer Line and Related Structures Construction**; 33341-** Ventilation, Heating, Air-Conditioning Equipment Manufacturing

Applications- Drinking water dispensers, Water efficiency enhancing technologies, Water purifiers, Dehumidifiers

Market Drivers-

The global water purifier market size is projected to grow from $33.65 billion in 2023 to $54.48 billion by 2030, at a CAGR of 7.6%.**; Global dehumidifier market** is valued at US$ 4.23 Billion in 2023 is expected to grow to US$ 7.94 Billion with a CAGR of 6.5% by the end of 2033

Research Lab

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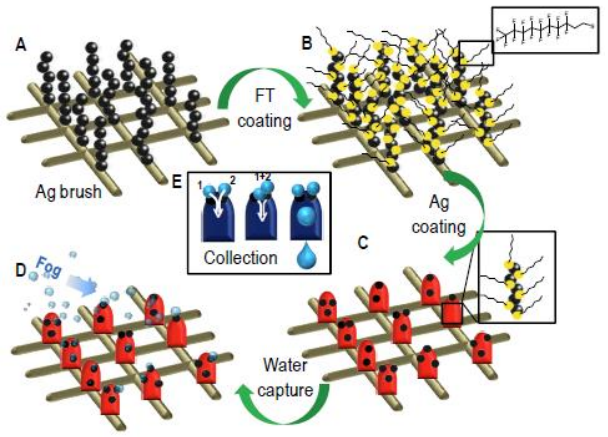

Figure: Schematic of **(a)** Ag nano-brushes synthesized by electrospray deposition **(b)** Hydrophobic Fluoro Thiol (FT) coated nano brushes **(c)** Hydrophilic patterned Ag nano-brushes **(d)** Atmospheric water capture by Ag nano-brushes.

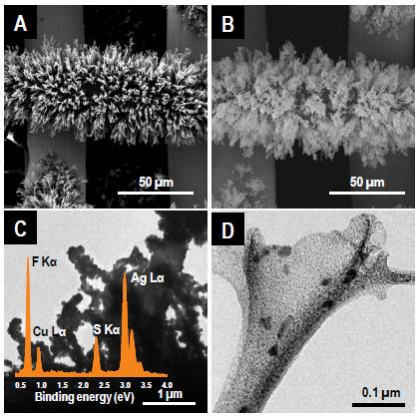

Figure: SEM images of **(a)** uncoated Ag nano-brushes **(b)** Ag nano-brushes with FT coating; and TEM images of **(c)** FT coated nano-brush with intact morphology **(d)** with higher magnification showing Ag nanoparticles and FT coating

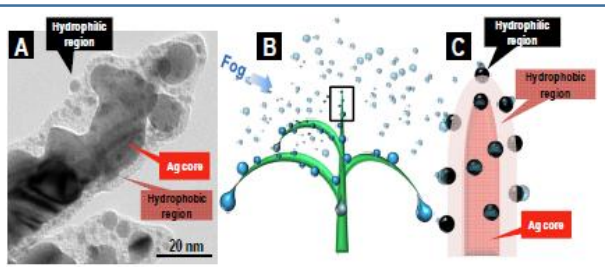

Figure: (a) TEM images of hydrophilic-hydrophobic patterned Ag nano-brushes **(b)** Schematic representation of atmospheric water capture by metallic grassland **(c)** Schematic representation of three regions corresponding to those in the TEM image of nano-brushes

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Technology

1. **Silver (Ag) nano-brushes consisting 1D nano-wires using electrospray deposition of Aqueous Silver Acetate solution on stainless steel mesh or TEM grid (without carbon coating) at ambient temperature. This creates a 'grassland ' morphology.**
2. **Coating of Ag nano brushes using a FluoroThiol (forms strong sulphur-metal bond) to create super-hydrophobic surface**
3. **Hydrophilic zone over the super-hydrophobic surface created using electro-spray deposition of Silver acetate solution using nano ElectroSpray deposition (n-ESI)**
4. The Ag core gives mechanical strength, the Fluorothiol coating creates hydrophobic background while Ag nano-particles embedded in the FT create hydrophilic zones.
5. Water condenses on the hydrophilic zones as small droplets, as the droplets grow in size they coalesce with droplets in adjacent zones. When the droplets are big enough they roll off the surface due to the hydrophobic background.

Key Features / Value Proposition

- Surface validated in relevant environment for atmospheric water capture at dewpoint at 40% relative humidity.
- Contact angle measurements show that nature of the surface remains the same after dew collection demonstrating the robustness of the surface.
- The developed system for water capture can be deployed easily in a decentralized manner. Whereas, conventional centralized water capture systems of dams face complex socio-economic hurdles.
- Water droplets on the developed surface were condensed at a much faster rate when compared to an unmodified steel mesh.
- Optical microscope image analysis shows high water capture rates at 30L H-1M2. With efficient humidity capture at even low relative humidities.

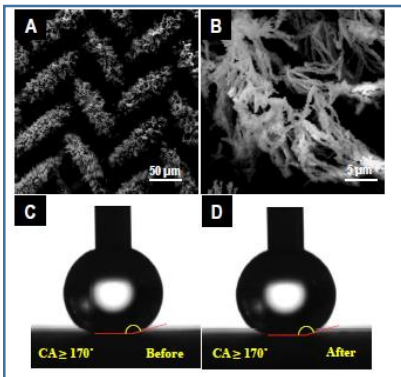

Figure: Surface morphology and contact angle remain intact before (A,C) and after (B,D) the water capture experiments

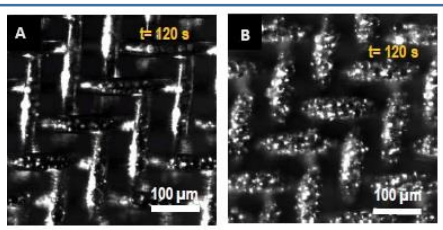

Figure: Optical images of (B) Ag-nano brushes showing better atmospheric water capture compared to (A) steel wire mesh

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