EcoFog: A Novel Composite Mesh for Passive Water Collection From Fog and High Relative-Humidity Environments

Todi, Diivij (School: Jayshree Periwal International School)
Gupta, Mrityunjay (School: Jayshree Periwal International School)

Over 2 billion people globally lack access to fresh water, and in recent years, fog harvesting has emerged as a promising solution in water-scarce regions. Yet, the only widely implemented system, the raschel mesh, fails to maximize water collection efficiency. On the other hand, current high-performance lab systems heavily rely on complex methodologies or non-biodegradable materials, hindering real-world deployment. To address this gap, EcoFog was developed: a scalable, environmentally-friendly fog harvesting mesh offering both higher water capture efficiency and faster drainage. A hydrophobic polylactic acid backbone was 3D-printed and coated with an electrospun porous matrix of polyvinyl alcohol and polyethylene oxide nanofibers to impart hydrophilicity. The electrospinning solution was further functionalized with an optimized concentration of titanium dioxide nanoparticles to introduce additional nucleation sites. Colloidal silica nanoparticles were introduced to increase the matrix's tensile strength for real-world conditions. The FESEM analysis confirmed the nanofibers' uniformity and small diameter, while the contact angle test confirmed the wettability contrast between the components. Under controlled fog conditions, EcoFog achieved a water collection rate of 17.3 L/m^2/day – 3.46x higher than raschel meshes. With a ~50% lower retained-water fraction and a 4x higher droplet formation rate, EcoFog exhibited increased nucleation, reduced clogging, and sustained water collection efficiency. Importantly, the mesh is fabricated using environmentally-friendly, widely available materials and scalable processes. At a life cycle cost projected to be ~40% lower than currently-used systems, EcoFog provides an efficient and scalable source of water for fog-prone regions.

Awards Won:
Third Award of $1,200