A Novel Water Harvesting Technology Based on 3D Printed Metal-Organic Frameworks

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The increasing demand for reliable and affordable clean water resources has driven global interest, particularly in dry climates. Metal–organic frameworks (MOFs) have emerged as promising sorbents for advanced water harvesting systems. However, conventional MOFs are typically synthesized as powders, requiring shaping for practical handling and integration into industrial processes. In this project, Selective Laser Sintering (SLS) 3D-printing is employed to transform MOF-303-PLA into bulk form. The initial phase involved producing a fully functional water harvesting device prototype, comprising of a printed MOF-303 part to maximize water adsorption capacity. The impact of SLS process on the water adsorption capability of MOF-303 was investigated through density, thermogravimetric and mechanical analyses. Density revealed minimal porosity, less than 0.05%, ensuring nearly void-free material. The TGA data revealed that MOF-303 maintains water adsorption capability without any significant loss. Mechanical testing revealed a notable enhancement, boasting a Young's modulus of 1080 MPa and a toughness of 2.1 J/m3. SolidWorks computational modeling was employed to analyze the geometry design and its influence on air flow dynamics. Notably, the analysis shows effective pressure distribution, with peak air pressure recorded at 101.37 Pa, coupled with predominant air velocities reaching up to 4 m/s. The elliptical shaping design strategically ensures optimal air flow channeling throughout the entire MOF structure. This innovative water harvesting approach provides a scalable and sustainable solution for tackling water scarcity by collaborating with stakeholders, integrating with existing infrastructure, and implementing monitoring and evaluation.

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