ADSORPTION ENHANCEMENT OF ATMOSPHERIC MOISTURE CAPTURE USING 3D-PRINTED TPMS GEOMETRY

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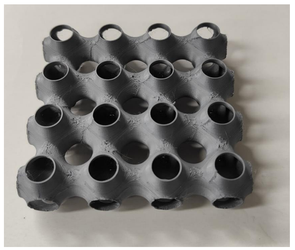
Research question: To identify geometries with high surface area-to-volume ratio to enhance adsorption of atmospheric water.

Motivation:

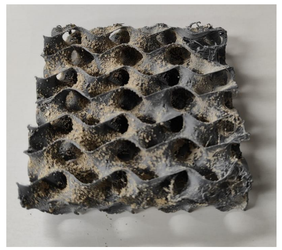
Water systems vital for ecosystems and human sustenance are strained, with over half of global wetlands lost. Air, abundant and accessible, offers diverse utility beyond breathing, underscoring its potential for various applications.

Research Methods & Challenges:

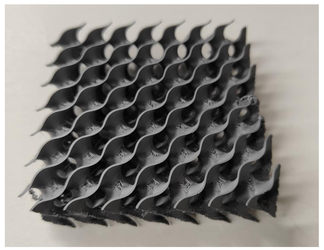
We selected TPMS (Triply Periodic Minimal Surface) that are proven to have high surface area-to-volume ratio.[1-2] These geometries were designed, 3D printed and tested in our lab.



Schwarz- Primitive

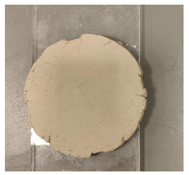


Gyroid



Schwarz- Diamond

To capture atmospheric moisture, the geometries can be printed either with plastic or clay and coated it with desiccant. With simple experiments water holding capacities were calculated. Silica gel was used as it has high moisture adsorbing capacity.



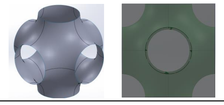
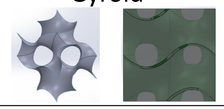
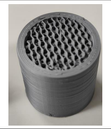
Clay Specimen

Clay specimen coated with desiccant

The major challenge is to 3D print the geometries with clay and coat them with desiccant.

Results:

Comparing all geometries, Schwarz-Diamond has the highest value of surface area-to-volume ratios, *Schwarz- Primitive < Gyroid < Schwarz- Diamond*

Geometries Unit Cell	Surface Area Ratio per unit cell (Calculated)	Pressure Drop across 1 inch sample (Pa) (Measured)	3D Printed geometries (1inch X 1 inch)
Schwarz Primitive 	1	441	
Gyroid 	1.31	377	
Schwarz Diamond 	1.63	461	

More complex geometries like Schwarz-Diamond have high surface area-to-volume ratios but also result in high pressure drops. We need lower pressure drop to reduce energy use. Further optimization needs to be done to lower the pressure drops while having high surface area-to-volume ratios.

Improved methods to coat desiccant on clay are being studied.

Acknowledgements :

1. Elzbieta Gawronska, Robert Dyja, A Numerical Study of Geometry's Impact on the Thermal and Mechanical Properties of Periodic Surface Structures, Materials, MDPI, 2021 Jan 16

2. I. Maskery, I.A. Ashcroft, The deformation and elastic anisotropy of a new gyroid-based honeycomb made by laser sintering, Additive Manufacturing , 21 August 2020

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