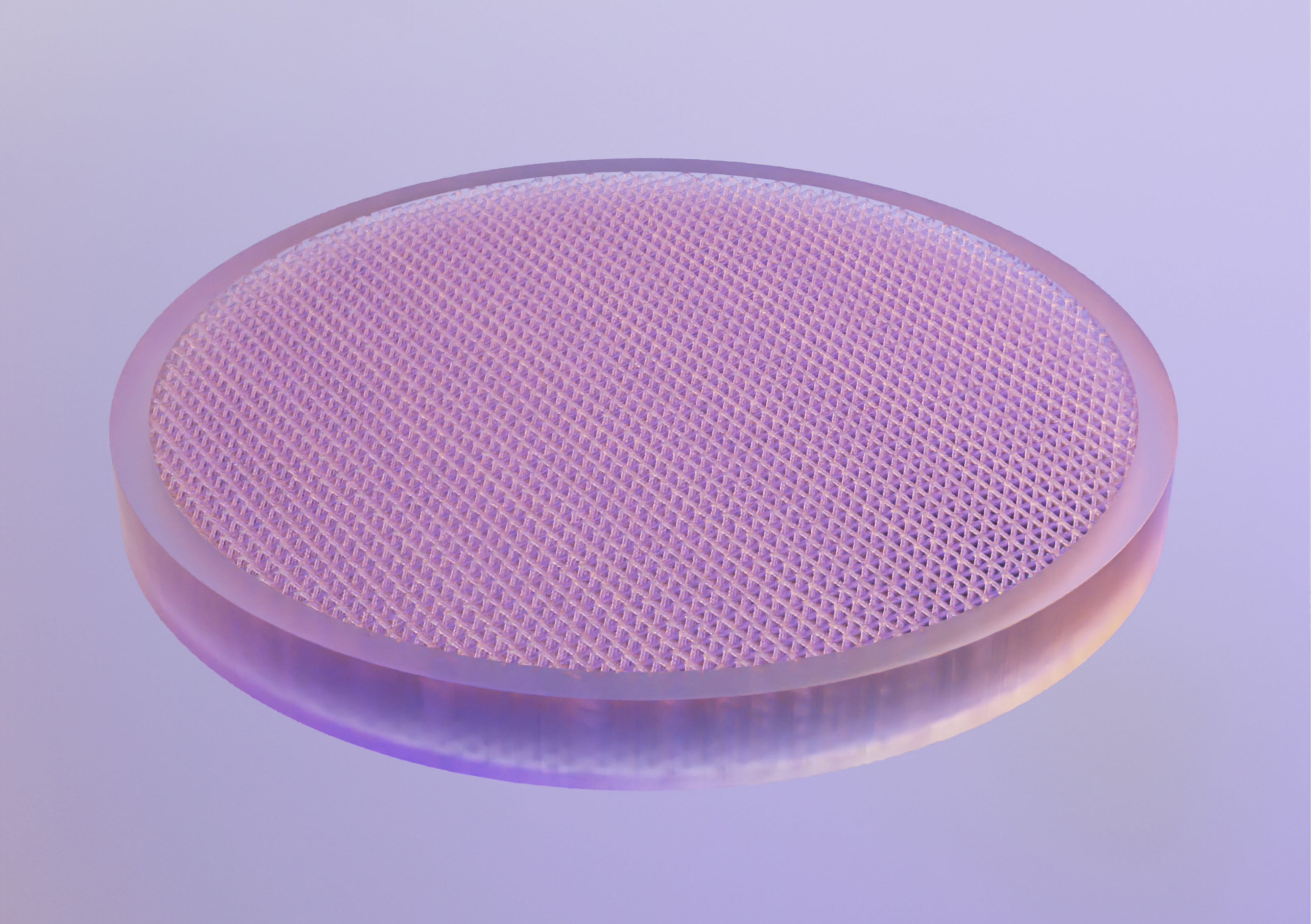

Bigger on the Inside

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October 31, 2022. Additive manufacturing has opened the door to the physical realization of metamaterials—lattice-like structures that are engineered at the small scale to have potentially extraordinary properties at the macro scale. These are sometimes called architected materials.

The relationship between surface area and volume for different metamaterials plays a key role in determining where specific unit cell architectures might find application. In some cases, the high surface area-to-volume ratio leads these materials to become highly efficient for use as filtration media or carbon capture mechanisms, as pictured in the artist's rendering on the obverse.

In other examples, metamaterials can be realized with interior geometry providing tailored responses to different directional forces such as compressions or shears; to have beneficial strength-to-weight ratios for lightweight components in aerospace and electric vehicles; to have a surface textures promoting tissue growth in orthopedic implants; or to have extremely high surface area combined with low pressure drop for energy transfer in the case of heat exchangers or batteries.

That 3D printing is, in principle, capable of realizing these remarkable innovations involving intricate geometric structures has led to the claim that, unlike conventional manufacturing, in 3D printing "complexity is free." Yet, to truly realize this promise, innovators require a digital treatment of 3-dimensional geometry that is precise, fast and mathematically sophisticated. It is therefore more accurate to say that the geometric complexity of the manufactured output is based on the mathematical underpinnings of the digital tools making it possible. By extension, the astonishing potential of additive manufacturing in spaces such as energy, climate tech, medicine and lightweighting all depend critically on innovations in geometry processing and computer graphics.

This reflection ties to the development of Metafold's Lightcycle Design for Additive Manufacturing software [1]. Rendering for this postcard by Tom Reslinski; software architecture by Daniel Hambleton.

[1] Hambleton, Reslinski & Ross. Systems and methods for 3D printing. Patent number WO2022174322A1, 2022.