

MECHANICAL METAMATERIALS

Mechanical properties of materials can be tailored by material composition but also by geometrical design. The field of mechanical metamaterials aims at exploiting exactly this twofold design freedom. Nanoscribe's Photonic Professional GT offers three-dimensionality (3D), submicron feature size and resolution as well as hierarchical structuring capability. Auxetics and mechanical cloaks are successfully demonstrated by polymeric structures. By subsequent post-processes such as surface coating or electro-plating, damage-tolerant lightweight materials are also made of composites, metals and ceramics.

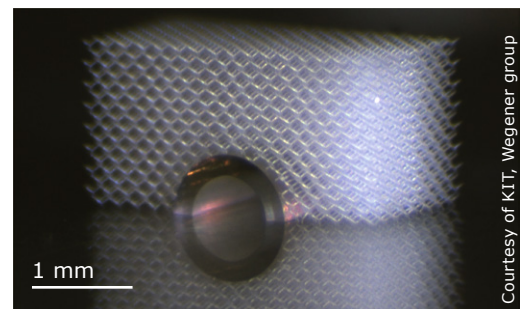


MECHANICAL CLOAK

Challenge: Fabrication of a structure with submicron feature size and millimeter-range dimensions for the precise tailoring of mechanical properties in a tiny volume.

Solution: An intricate pentamode cloak microstructure with $2 \times 1 \times 1 \text{ mm}^3$ overall dimensions is 3D printed by using the liquid photoresist IP-S.

Source: DOI: 10.1038/ncomms5130



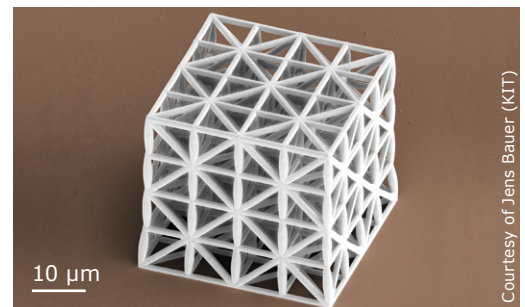
Courtesy of KIT, Wegener group

HIGH-STRENGTH CERAMIC POLYMER COMPOSITE

Challenge: Fabrication of a 3D cellular material with low filling factor built of submicron elements demonstrating size-dependent strengthening effects.

Solution: 3D polymeric structures with submicron feature size are printed. Ceramic composites are then obtained by subsequent ALD coating with alumina.

Source: DOI: 10.1073/pnas.1315147111



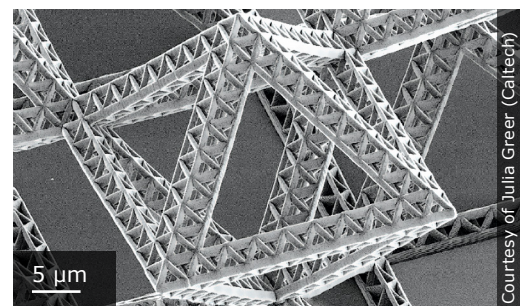
Courtesy of Jens Bauer (KIT)

RESILIENT 3D HIERARCHICAL METAMATERIAL

Challenge: Manufacturing of 3D fractal-like architectures with features in the sub-micron regime for the attainment of various mechanical properties, e.g. ultralightweight, recoverability.

Solution: 3D hierarchical nanolattices with individual beams comprised of multiple self-similar unit cells with length scales spanning over four orders of magnitude are fabricated.

Source: DOI: 10.1073/pnas.1509120112



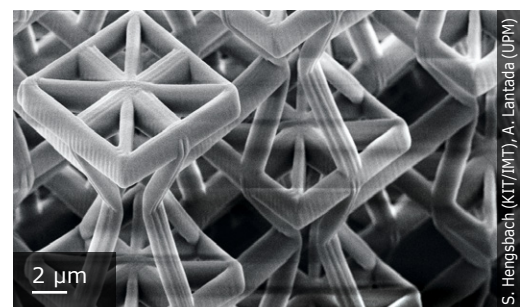
Courtesy of Julia Greer (Caltech)

AUXETICS / NEGATIVE POISSON RATIO MATERIAL

Challenge: Micro-manufacturing of a material that laterally expands when stretched and shrinks when compressed, for applications in biomimetics or magneto-mechanical microsystems.

Solution: 3D complex geometries with submicron details are fabricated precisely, reproducibly and mechanically stably.

Source: DOI: 10.1088/0964-1726/23/8/085033



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