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PARAMETRIZATION OF 2D MICROSTRUCTURES INSPIRED BY TOPOLOGY OPTIMIZATION TO ATTAIN THEORETICAL LIMITS OF ELASTIC PROPERTIES

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Abstract. It is known that materials with multiple length scales (such as multiple rank laminates) attain Cherkaev-Gibiansky theoretical bounds of elastic properties in specific regions of the bulk-shear moduli space. However, topology optimization, formulated as an inverse homogenization problem, has proven to be a successfull tool to obtain microstructures with almost extreme properties and to reveal underlying mechanisms existing in these materials, with a single length scale. In this work we use topology optimization as a source of inspiration to propose sophisticated mechanical metamaterials with two length scales and parametrize them to bring near the full theoretical limits. We particularly emphasize cases corresponding to the most interesting and challenging demeanours, such as negative Poisson ratio, Walpole point and maximal stiffness. Crystallographic symmetries, specifically hexagonal ones, are included in the designs to impose isotropy to the material.