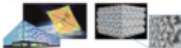




The strength of ultralightweight membranes and additively manufactured metamaterials

From nature to structural applications, the quest for ultralightweight and strong materials drives the progress toward highly efficient systems. In this framework, membranes and cellular solids represent two classes of materials that offer unmatched strength-to-weight ratios. The talk discusses advances in the modeling, design and characterization of ultralightweight solids to enhance their mechanical properties and promote their use in several engineering applications, from sustainable buildings to additive manufactured robotic components. In the first part, we present a new imaging technique to precisely characterize the yield strength of membrane materials, thus overcoming the limitations of the available experimental methods. In the second part, we demonstrate how the mechanical properties of lightweight metamaterials can be enhanced by altering their architecture through the redistribution of solid material along the cell walls. Analytical calculations, finite element simulations coupled with topology optimization and experiments are performed to maximize stiffness, yield and buckling strength of additively manufactured architected lattices.



Left: applications of flexible membranes in building facade and space engineering. Right: computed tomography images of an additively manufactured lattice structure with cell and cell wall thickening.

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