Graphene Hollow Capsule Based Closed Cellular Structure for Ultralight, Strong, and Superelastic Materials

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Structural materials with ultra-light density and high strength derive transformative impacts in the construction, aerospace, and transportation industries. These materials can be realized by assembling ingeniously designed building units (BUs) into interconnected structures. This study uses a hierarchical design strategy starting from the functionalized graphene oxide nanosheets at the molecular- and nanoscale, leading to the microfluidic fabrication of hollow capsule at the microscale. Then, capsules are assembled into centimeter-scale 3D structures. Subsequently, these structures are transformed into self-interconnected and reinforced closed-cellular network. The 3D graphene structure exhibits the Young's modulus above 177 kPa with a light density of 4.7 mg cm^{-3} and sustaining up to 87% of the compressive strain benefiting from efficient stress dissipation through the complete space-filling closed-cellular network. The method opens a new pathway for designing lightweight, strong, and superelastic materials.