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

오민준, 여선주[1], 전현민, 이민환[2], 배중건[2], 김예슬, 박경진[3], 이승우[3], Daeyeon Lee[4], 원병묵, 이원보[2], 권석준[1], 유필진†

성균관대학교; [1]KIST; [2]서울대학교; [3]고려대학교; [4]University of Pennsylvania

(pjyoo@skku.edu†)

Advanced materials with low density and high strength impose transformative impacts in the construction, aerospace, and automobile industries. These materials can be realized by assembling well-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 solid bubbles at the microscale. Then, bubbles 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 300 kPa with a light density of 7.7 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.