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Manufacture of multifunctional architectures for energy applications

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Lawrence Livermore National Laboratory develops and utilizes multifunctional hybrid materials for a variety of applications. Over the last few years, we have focused our attention on developing new additive manufacturing methods to produce structural with controlled architectures and anistropic physical properties. Three-dimensional printing of viscoelastic filled silicone inks, for example, can be used to create porous, elastomeric architectures with mechanical properties governed by the ordered arrangement of their sub-millimeter struts. These structures exhibit markedly distinct load response with directionally dependent behavior, including negative stiffness. More broadly, these findings suggest the ability to independently tailor mechanical response in cellular solids via micro-architected design. Such ordered materials may one day replace random foams in mechanical energy absorption applications.

We will also review our progress fabricating periodic graphene aerogel microlattices, possessing an engineered architecture via similar additive methods. The 3D printed graphene aerogels are lightweight, highly conductive and exhibit supercompressibility (up to 90% compressive strain). Moreover, the Young's moduli of the 3D printed graphene aerogels show an order of magnitude improvement over bulk graphene materials with comparable geometric density and possess large surface areas. Adapting the 3D printing technique to graphene aerogels realizes the possibility of fabricating a myriad of complex aerogel architectures for a broad range of applications.

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