Multifunctional Properties of 3D Printed Graphene/MXene based Architected Cellular Materials

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Abstract
The mathematically well-known triply periodic minimal surfaces (TPMS) have unique topological characteristics making them ideal for creating metamaterials and structural systems with excellent multifunctionality [1], especially fabricated out of 2D materials such as graphene and MXene. In this work, we present a scalable fabrication method of ultralightweight standalone TPMS-based architected cellular materials out of graphene/MXene using 3D printed sacrificial scaffolds [2,3]. The fabrication method includes graphene/MXene coating of the TPMS scaffolds via a hydrothermal process, followed by drying and thermal etching of the scaffold. Various characterization techniques are used to assess the quality of the standalone graphene/MXene cellular materials. Also, the thermo-electro-mechanical properties of these cellular materials as a function of the graphene/MXene concentration and cell topology are evaluated. Furthermore, their performance in various applications is assessed. Some of these demonstrations are in collaboration with industry such as Dassault Aviation. This true academia-industry collaboration will be emphasized in this talk, which is yielding fruitful applications of these novel types of architected metamaterials made of various 2D materials.

References

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[2] Ashraf, J., Fu, J., Liao, K., Chan, V., Abu Al-Rub, R.K., “Scalable synthesis, characterization and testing of 3D architected gyroid graphene lattices from additively manufactured templates,” Journal of Micromechanics and Molecular Physics, Vol. 6, No. 3, pp. 13-24, 2021.
[3] Taher, S., Ashraf, J., Liao, K., Abu Al-Rub, R.K., “Mechanical properties of graphene-based Gyroidal sheet/shell architected lattices,” Graphene and 2D Materials, Vol. 9, pp. 161-178, 2023.

Figures

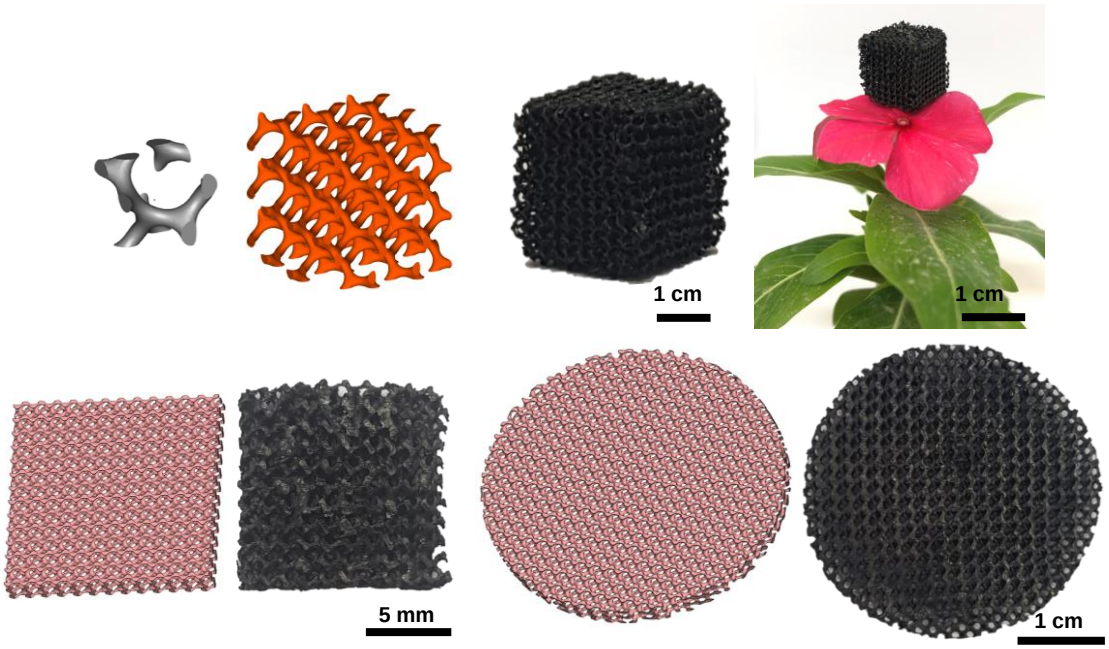

Figure 1: Designed and fabricated TPMS-based graphene architected cellular materials.