Novel method to construct all-graphene macrostructures

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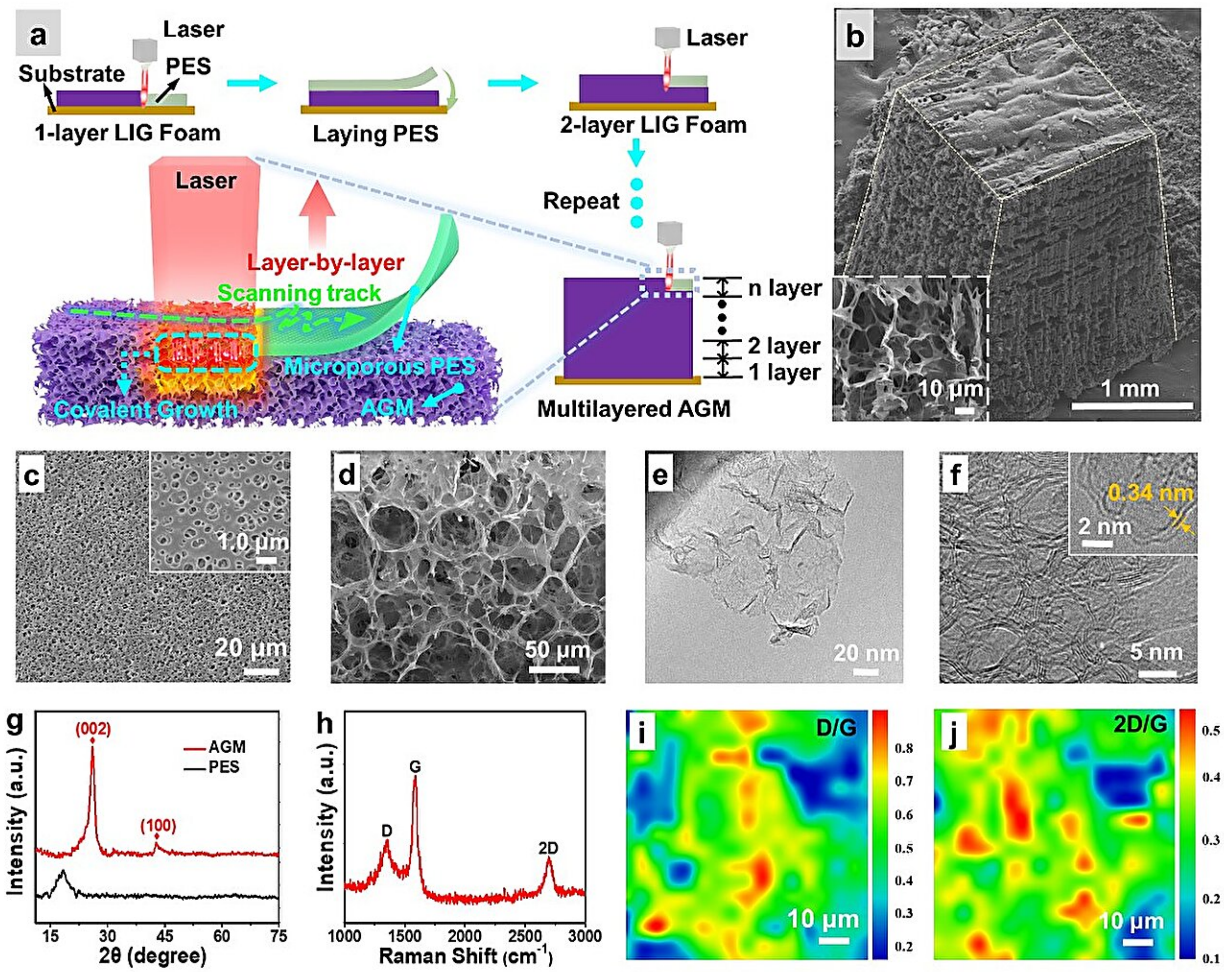

Layer-by-layer covalent growth and the characterization of AGMs. Credit: Li Nian

Researchers from Hefei Institutes of Physical Science (HFIPS), Chinese Academy of Sciences (CAS), have proposed a laser-assisted layer-by-layer covalent growth method to prepare highly crystalline all-graphene macrostructures (AGMs). The study was published in *Advanced Functional Materials*.

Graphene is a two-dimensional carbon material known for its exceptional mechanical, electrical, thermal, and optical properties. To facilitate its large-scale applications, it is crucial to efficiently prepare and assemble graphene at the macroscopic level.

However, conventional methods such as liquid phase self-assembly, 3D printing, and catalytic template techniques can only achieve non-covalent weak interactions between graphene sheets, resulting in discontinuities in the crystal structure. This limitation hampers electrical properties of graphene macrostructures.

In this study, a covalently interconnected AGM with micro-to-macro scalable electrical properties was prepared by lamination of microporous polyethersulfone (PES) membrane. Each stack layer of PES membrane was completely carbonized and seamless interlayer boding was achieved in an air environment using a laser.

Through molecular dynamics simulation, the researchers further revealed the covalent growth mechanism of AGM. Compared to non-covalent assembly, this approach achieved a 100-fold increase in cross-layer conductivity.

The effectiveness of AGMs has been demonstrated in applications such as supercapacitor electrodes. The covalent growth technique for AGMs is fundamentally important not only in energy storage but also in other fields such as electronics, electromagnetic shielding, and sensors, where efficient and high-quality methods for preparing macroscopic graphene are essential.

More information: Yanping Song et al, Macro-Sized All-Graphene 3D Structures via Layer-by-Layer Covalent Growth for Micro-to-Macro Inheritable Electrical Performances, *Advanced Functional Materials* (2023). [DOI: 10.1002/adfm.202305191](https://doi.org/10.1002/adfm.202305191)

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