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Efficient Synthesis of Holey Graphene by Microwave-Assisted Chemical Etching

Background

Graphene is a carbon-based material with exceptional versatility across a wide range of electrical, electrochemical, and biomedical technologies. Despite its many desirable properties, graphene's 2D layered structure can hinder ion and molecule transport across its basal plane. This can be especially problematic when graphene layers are stacked or assembled in dense structures such as in energy storage applications. More recently, the introduction of holey graphene—graphene sheets with uniformly distributed nanoholes—may provide a solution to the mass transport issue. However, current production methods for holey graphene is energy-intensive and time-consuming, with limited potential for commercial scaling. Therefore, a scalable and energy-efficient process for synthesizing holey graphene would significantly advance the application potential of graphene.

Invention Description

Researchers at Arizona State University have developed a new fabrication process for holey graphene sheets that is fast, scalable, and economical. Through the use of readily available chemicals and microwave energy, graphene oxide nanosheets are efficiently heated to create openings in the carbon structure. The distribution and size of the resulting nanoholes can be tuned by adjusting process parameters. Relative to competing methods, this innovation decreases processing time from hours to less than 5 minutes. With these attributes, this process can provide the basis for mass production of holey graphene for commercial use.

Potential Applications

- Energy storage systems
- Supercapacitors
- Membranes
- Biomaterials
- Sensors

Benefits and Advantages

- Scalable – Using readily available raw materials without the need for costly pretreatments enables high-volume production
- Practical – Method significantly reduces the time, energy, and costs associated with holey graphene production
- High-Performing – Synthesized holey graphene enhances mass transport across basal layers of graphene, increasing performance in electrochemical applications
- Tunable – Size and distribution of graphene holes can be controlled effectively by process parameters
- Environmentally Friendly – Process does not involve hazardous chemicals or byproducts