Plasma Synthesis of Copper-Carbon Composites

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Finding advanced materials for efficient thermal management systems remains a challenge in contemporary engineering. This research presents a novel approach utilizing atmospheric pressure plasma to synthesize copper particles encapsulated with carbon, aiming to address critical limitations in current heat dissipation technologies.

Plasma processing stands as an excellent method for nanostructure synthesis owing to its distinctive properties. While high-energy plasmas have been extensively studied, low-temperature plasmas present viable solutions for large-scale nanomaterial production, being adaptable to industrial settings without the constraint of vacuum chambers. Apart from plasma temperature and pressure, the choice of carbon source holds paramount importance in carbon nanostructure synthesis within the plasma system. Depending on the carbon source employed, carbon nanostructures can be generated either dispersed within the plasma volume or directly deposited onto substrates or plasma-treated liquids, facilitating the addition of metallic substrates (in powder form) and encapsulating them with desired nanostructures.

This research integrates atmospheric pressure plasma with copper particles to induce controlled carbon encapsulation, thereby enhancing thermal conductivity and mechanical properties crucial for effective heat transfer. Through precise tuning of process parameters and characterization techniques, we aim to achieve homogenous dispersion of carbon within the copper matrix, optimizing the composite's thermal performance. For this purpose, we use dielectric barrier discharge (DBD) jet and alcohols and hydrocarbon as a liquid source of carbon. With this setup we managed to produce amorphous carbon, graphite and graphene dispersed in liquid and are starting to optimize the copper encapsulation process.

This research aligns with the growing demand for sustainable and scalable solutions in thermal management, offering a promising avenue to mitigate challenges posed by escalating heat flux densities in various applications. Moreover, the utilization of atmospheric pressure plasma facilitates cost-effective and environmentally benign synthesis pathways, ensuring compatibility with industrial-scale production.