

Inkjet Printing for Advanced Electrode Fabrication: Precision, Efficiency, and the Role of Graphene-Based Materials in Electrochemical Applications

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Inkjet printing has emerged as a versatile and powerful alternative to traditional methods for modifying working electrodes, particularly in electrochemical applications. This technique provides precise control over material deposition, allowing for the fabrication of highly reproducible and customized electrode surfaces. Unlike conventional approaches like drop casting, spin coating, or photolithography, inkjet printing supports layer-by-layer assembly, enabling the integration of complex, multi-material structures with nanometer precision. Additionally, it minimizes material waste, reduces fabrication time, and preserves the integrity and functionality of sensitive components like nanomaterials and biological molecules.

Compared to traditional printing techniques like screen-printing, inkjet printing offers significant advantages in resolution, material efficiency, and flexibility. It is compatible with a wider range of substrates, making it ideal for rapid prototyping of electrode designs.

A major advancement in inkjet-printed electrodes is the use of graphene derivatives functionalized with specific chemical groups or graphene-based materials engineered at the single-atom level. This allows for precise surface modifications, tailoring electrodes for specialized applications such as biosensing. For example, it enables the attachment of bio-relevant molecules like antibodies or aptamers, improving their functionality in targeted sensing. Single-atom engineering further enhances the performance of graphene by precisely positioning atoms within the lattice, greatly boosting catalytic activity, electrical conductivity, and surface area.