Core@Shell Nanomaterials as Conductive Inks for Flexible Printed Electronics

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Bimetallic core@shell nanomaterials have attracted significant attention as functional components of conductive nanoinks, enabling reduced noble metal consumption while maintaining high conductivity [1, 2]. The performance of printed nanomaterials depends on multiple factors, including ink formulation (nanomaterial type, size, shape, stability, and rheology), substrate properties (surface energy, wettability, and roughness), and the printing method. Typically, conductive structures are formed through three stages: nanoink preparation, deposition, and post-printing treatment such as drying and sintering.

In this work, we developed two approaches for fabricating conductive coatings based on nanoinks composed of copper@silver nanowires (NWs) and nickel@silver nanoparticles (NPs). Both types of core@shell nanostructures were synthesized via a galvanic displacement process, yielding air-stable Cu@Ag NWs (~100 nm in diameter and 15–20 μm in length) and Ni@Ag NPs with an average size of ~220 nm.

The obtained nanomaterials were used to fabricate conductive films using scalable deposition techniques and low-temperature post-processing. Uniform Cu@Ag NW networks were achieved after sintering at 100 °C in a vacuum oven, while Ni@Ag NP-based coatings required a combined chemical and UV–Vis-assisted sintering process to ensure effective particle coalescence. The resulting films exhibited comparable electrical conductivity on the order of 10^4 S/m, attributed to favorable morphology and efficient interparticle connectivity.

These results demonstrate that core@shell nanoinks based on Cu@Ag or Ni@Ag nanostructures enable the fabrication of conductive coatings at low temperatures, making them suitable for heat-sensitive substrates such as polymers or paper. This approach offers a promising pathway toward cost-effective, scalable production of conductive elements for next-generation printed and flexible electronic devices.

References:

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