Development of Graphene-based Conductive Inks with Bio-Derived Matrices for Printed Electronics

Nimmi C Sekhar, Sinu P, Devika P, Alex P James

India Graphene Engineering and Innovation Centre, Digital Science Park, Kabani Building, Technopark Phase 4, Trivandrum, 695317, Kerala, India.

E-mail: ncsekhar@igeic.org

Abstract

Despite the widespread use of graphene and other 2D material-based conductive inks in printed electronics applications, their industrial scalability is primarily constrained by the critical tradeoff between dispersion stability and electrical conductivity. While silver-hybridized pyrrolidone-based matrices achieve excellent conductivity, their adoption is limited by high costs and energy-intensive processing. In this work, a bio-derived anionic polysaccharide matrix is utilized within an optimized hybrid solvent system. The Jouyban-Acree model was utilized to optimize the isopropyl alcohol (IPA)/deionized water hybrid solvent ratio, matching the surface tension of the hybrid solvent with that of graphene to minimize the interfacial enthalpy of mixing. This approach yields a stable, well-dispersed graphene ink that balances high conductivity with industrial scalability, removing the need for expensive synthetic binders. The anionic polysaccharide acts as a surfactant to stabilize the graphene flakes, while silver nanoparticles were incorporated to provide a network of high-conductivity pathways. Experimental validation with the Tyndall effect confirmed the dispersion stability, while Voltage Linear Sweep characterization using parameter analyzer demonstrated an ohmic response, achieved by preserving the graphene aspect ratio through high-intensity continuous kinetics. Furthermore, this study evaluates the impact of post-treatment methods like ambient curing, thermal matrix reduction, and chemical treatment via acid immersion, providing a scalable framework for high-performance printed electronics.

References

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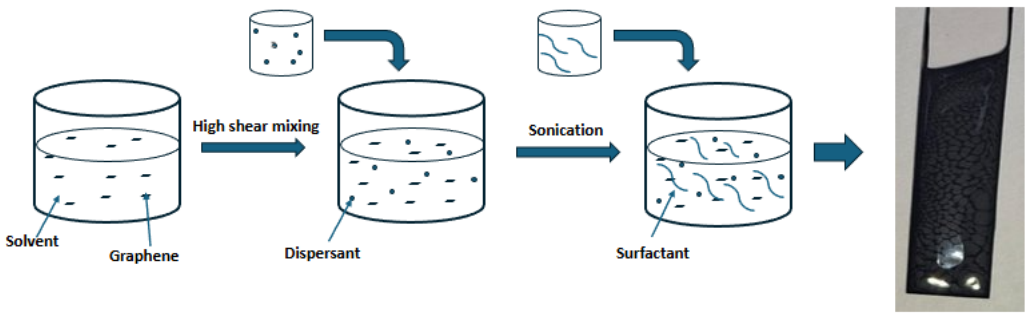

Figure 1: Preparation of graphene based conductive ink