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Development of graphene-enhanced polymer nanocomposites for next-generation flexible electronics

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Statement: Flexible electronics require materials with exceptional electrical conductivity, mechanical flexibility, and thermal stability. Conventional polymers often lack the performance needed for high-efficiency applications. This study investigates graphene-enhanced polymer nanocomposites as a promising class of materials for flexible electronic devices.

Methodology: A series of polymer nanocomposites were synthesized using a solution casting method, integrating varying concentrations (0.1% to 2% w/w) of reduced graphene oxide (rGO) into a polyvinyl alcohol (PVA) matrix. The dispersion quality was optimized through ultrasonication and surfactant-assisted exfoliation. The electrical conductivity, tensile strength, thermal stability, and surface morphology of the composites were analyzed using four-point probe measurements, tensile testing, TGA, and SEM respectively.

Results: The incorporation of rGO significantly improved the properties of the PVA matrix. At 1% rGO loading, electrical conductivity increased by over 300% compared to the pure polymer. Tensile strength was enhanced by 47%, and thermal degradation temperatures increased by 28°C, indicating greater thermal resistance. SEM analysis confirmed uniform graphene dispersion at lower concentrations, while higher loadings showed some agglomeration.

Conclusion: Graphene-enhanced PVA nanocomposites demonstrate excellent potential for use in flexible electronic devices. Optimal enhancement was observed at 1% rGO loading, balancing mechanical, thermal, and electrical properties. These findings support the scalability of graphene-polymer nanocomposites in the production of lightweight, flexible, and durable components for next-generation wearable technologies and foldable circuits. Further studies are ongoing to explore large-scale fabrication and device integration.

Biography

Thomas Hamilton, PhD, is a Senior Lecturer in Materials Engineering at the University of Manchester, United Kingdom. He specializes in nanomaterials, polymer composites, and electronic materials for advanced device applications. Dr. Hamilton received his doctorate from Imperial College London and has published over 40 peer-reviewed articles in materials science and nanotechnology. He serves on the editorial board of the Journal of Composite Materials and collaborates with leading UK industries on sustainable materials innovation. His recent research focuses on graphene-based multifunctional composites and their role in transforming flexible electronics manufacturing.

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