

High-Performance Hemp-Derived Conductive Composites

Executive Summary

This proposal targets the development of electrically conductive, structurally viable composites using hemp-derived carbon nanosheets in epoxy and bio-epoxy systems. The focus is on achieving ultra-low percolation thresholds and competitive conductivity using fully or predominantly bio-derived inputs.

Core Hypothesis

Hemp-derived carbon nanosheets can achieve electrical percolation below 1 wt% loading in epoxy systems, outperforming conventional biochar by at least an order of magnitude in percolation efficiency.

Target Performance Metrics

- Percolation threshold: $< 1 \text{ wt\%}$
- Electrical conductivity: $> 10^{-2} \text{ S/m}$
- Mechanical retention: $> 80\%$ tensile strength vs neat resin

Primary Application Target

Lightweight EMI shielding materials and conductive structural panels for electronics and energy systems.

Experimental Plan

Phase 1: Baseline epoxy vs bio-epoxy comparison with nanosheet fillers.

Phase 2: Percolation mapping (0.1–5 wt%).

Phase 3: Hybrid systems (nanosheets + biochar).

Phase 4: Fully bio-based composite (hemp epoxy + lignin curing + fibers).

Characterization

- Electrical conductivity (4-point probe)
- Mechanical properties (tensile, modulus)
- Thermal stability (TGA, DSC)
- Morphology (SEM)

Key Technical Risks

- Nanosheet agglomeration and dispersion limits
- Weak interfacial bonding in bio-epoxy systems
- Performance tradeoffs in fully bio-based curing systems

Strategic Positioning

This work positions hemp-derived nanocarbons as a viable platform for sustainable conductive composites, bridging structural materials and functional electronics.

Collaboration Opportunity

Seeking collaboration to access hemp-derived nanosheets, validate percolation behavior, and co-develop high-impact publications and scalable materials.