
Standard Operating Procedure (SOP) for Hempoxy Prototyping

1.0 Purpose
The purpose of this SOP is to provide a standardized procedure for the synthesis and testing of Hempoxy composite materials, ensuring consistency and accuracy in the development of versions 1.1 through 1.4.
2.0 Scope
This SOP applies to all laboratory activities related to the prototyping of Hempoxy, including material synthesis, composite fabrication, mechanical testing, and the analysis of environmental performance (waste sequestration and degradation).
3.0 Responsibilities
All personnel involved in the prototyping process are responsible for understanding and adhering to this SOP. The Principal Investigator is responsible for ensuring all procedures are followed and all data is meticulously recorded.

4.0 Procedure: Phased Prototyping

This procedure is broken into three distinct phases, mirroring the developmental stages of the Hempoxy project.

4.1 Phase I: Foundational Composite (V1.1)

This phase validates the core material system and its performance.

1. **Material Preparation:**
    - Synthesize Epoxidized Hemp Oil (EHO) from hemp biomass according to established protocols.
    - Synthesize Carboxylated Hemp-Derived Carbon Nanosheets (HDCNS) and pyrolyzed hemp biochar.
    - Verify the purity and consistency of all bio-derived inputs.
2. **Composite Fabrication:**
    - Measure and mix the EHO resin with the reactive diluents and curing agents in a fume hood.
    - Introduce the HDCNS and biochar fillers, ensuring even dispersion via methods like

sonication.
   - Cast the composite into molds and cure under controlled temperature and pressure conditions as determined by initial testing.
3. **Mechanical Testing:**
   - Conduct tensile strength tests on the cured composite samples.
   - Record and analyze data to verify if the baseline performance target of ≥110-150 MPa has been met.

4.2 Phase II: Advanced Innovations (V1.2 & V1.3)

This phase integrates the waste upcycling and controlled degradation mechanisms into the core composite.

1. **Waste Integration (V1.2):**
   - Procure and prepare waste-derived functional fillers (WDFs) such as ground microplastics or Styrofoam.
   - Disperse WDFs into the Hempoxy resin matrix before curing.
   - Conduct post-curing analysis to measure the waste sequestration rate, verifying that the target of 99% is met.
2. **Controlled Degradation (V1.3):**
   - Introduce specific "cleavable linkers" into the resin formulation.
   - After curing, subject samples to controlled degradation triggers (e.g., UV exposure, specific pH baths, or thermal shock).
   - Measure the mass loss and filler recovery rates to validate the "circularity" hypothesis of the design.

4.3 Phase III: Commercial Viability (V1.4)

This phase transitions the material toward market readiness and involves scalability and a comprehensive life-cycle analysis.

1. **Scale-Up Testing:**
   - Replicate successful Phase I and II formulations using larger batch sizes and industrial-scale processes like twin-screw extrusion.
   - Analyze the impact of scale on material properties and consistency.
2. **Life Cycle Assessment (LCA) Data Collection:**
   - Methodically document every input, energy use, and output waste stream for the entire prototyping process. This data is crucial for the final LCA to benchmark Hempoxy's environmental footprint.

3. **Final Documentation:**
   - Compile all data, results, and observations into a master file for submission to potential investors, collaborators, or for a formal certification review.

5.0 Documentation and Record Keeping

All lab work must be recorded contemporaneously in a bound, paginated laboratory notebook using permanent ink. Each entry must be dated, signed by the researcher, and witnessed by a second party. All raw data, graphs, and analytical results must be securely attached or digitally archived with clear references in the notebook. This is the only way to ensure the integrity and legal defensibility of your research.