Hempoxy: Open-Source Prior Art on Hemp Nanosheet–Epoxy Nanocomposites

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Abstract

This paper establishes and releases into the public domain **Hempoxy**, a new class of nanocomposite materials defined as epoxy resins reinforced with hemp-derived nanosheets (cellulose, lignin, or carbonized hemp). While the use of hemp in composites is an active area of research and commercialization, this document provides a formal classification and framework for this technology. By publishing this disclosure, Hempoxy is established as prior art to prevent monopolization through restrictive patents and ensure open access to sustainable nanocomposite innovation. This paper defines Hempoxy variants (1.0–1.3), describes processing methods, contextualizes the technology within the existing scientific and industrial landscape, and outlines applications in military, aerospace, construction, consumer, and ecological sectors.

1 Introduction

Epoxy composites, typically reinforced with carbon or glass fibers, are foundational structural materials in the aerospace, automotive, and consumer goods sectors. However, their production is resource-intensive, petroleum-dependent, and poses significant environmental challenges. In response, industries are turning to sustainable alternatives, with hemp emerging as a leading candidate.

Hemp is an abundant, renewable biomass resource containing cellulose, lignin, and carbonizable fractions. Through nanoprocessing, these components can be converted into nanosheets with properties analogous to nanocellulose or graphene, offering high surface area, exceptional mechanical reinforcement, barrier properties, and tunable conductivity.

This potential has not gone unnoticed. Industrially, companies like Bio Fiber Industries are developing hemp fiber composites for automotive parts, while Rare Earth Global is creating hemp-based construction materials, including a ”Hemp nanocomposite.” In the scientific and patent landscape, prior art includes a U.S. patent for composites using carbonized hemp filler milled to the nanoscale (¡10 microns) and published research on converting hemp fibers into interconnected carbon nanosheets for high-performance supercapacitors.

Building upon this foundation, this paper formally defines **Hempoxy** as an epoxy nanocomposite where reinforcement is provided specifically by hemp-derived nanosheets, not conventional fibers. This disclosure aims to classify and unify this emerging field, placing it squarely in the public domain to foster open and collaborative innovation.

2 Definition of Hempoxy

Hempoxy is a class of nanocomposites composed of an epoxy resin matrix and hemp nanosheet reinforcement.

2.1 Types of Hemp Nanosheets

- **Cellulose nanosheets**: Derived via acid hydrolysis or mechanical exfoliation of hemp fibers; prized for high strength and biodegradability.
- **Lignin nanosheets**: Extracted through lignin fractionation; known to impart UV resistance and flame retardancy.
- **Carbonized hemp nanosheets**: Produced via pyrolysis/carbonization of hemp biomass. These nanosheets confer electrical conductivity and ballistic resistance, building on established research demonstrating the feasibility of creating high-performance carbon nanomaterials from hemp precursors.

2.2 Matrix Resins

- Conventional petro-epoxy.
- Epoxidized hemp oil (a fully bio-based resin).
- Hemp lignin–derived epoxy resins.

3 Variants of Hempoxy

To provide a clear framework for development, the following variants are defined:

- **Hempoxy 1.0**: The baseline formulation, using any type of hemp nanosheet in a standard petroleum-based epoxy matrix.
- **Hempoxy 1.1**: A fully bio-based system, combining hemp nanosheets with a matrix of epoxidized hemp oil and/or a modified hemp lignin resin.
- **Hempoxy 1.2**: A circular economy variant, incorporating micro-pollution (e.g., captured carbon) or processed waste fillers alongside hemp nanosheets.
- **Hempoxy 1.3**: A recyclable or reversible composite, featuring engineered breaking agents in the matrix to allow for recovery and reuse of the nanosheet reinforcement.

4 Material Properties

Based on the properties of its constituent parts, Hempoxy is projected to exhibit the following characteristics:

- **Mechanical**: High tensile strength and modulus at a lower density than traditional composites.
- **Thermal**: Improved thermal stability and fire resistance, particularly with lignin and carbonized nanosheets.
- **Barrier**: Reduced gas and liquid permeability due to the high aspect ratio and tortuous path created by aligned nanosheets.

- **Electrical**: Tunable conductivity, ranging from insulating to conductive, achieved by using carbonized hemp nanosheets.
- **Environmental**: Designed for biodegradability or recyclability depending on the chosen resin system and variant.

5 Processing Methods

5.1 Nanosheet Extraction

- **Acid hydrolysis**: For extracting high-crystallinity cellulose nanosheets.
- **Mechanical shear exfoliation**: A solvent-free method for producing nanosheets.
- **Lignin fractionation**: Isolation and processing of lignin into nanoplatelets.
- **Pyrolysis/carbonization**: Controlled heating of hemp biomass in an inert atmosphere to produce conductive carbon nanosheets.

5.2 Composite Fabrication

- **Dispersion**: Ultrasonication or high-shear mixing to uniformly disperse nanosheets in the liquid epoxy resin and prevent agglomeration.
- **Curing**: Polymerization of the epoxy matrix using amine hardeners, photo-curing (UV light), or novel bio-catalyzed curing agents.
- **Manufacturing**: Final composite fabrication via casting, hot-pressing, pultrusion, or additive manufacturing (3D printing).

6 Applications

The tunable properties of Hempoxy make it suitable for a wide range of applications:

- **Aerospace and automotive**: Lightweight structural components, interior panels, and battery casings.

- **Military**: High-strength, lightweight armor, helmets, and unmanned aerial vehicle (drone) components.
- **Construction**: Durable and insulating building panels, protective coatings, and sustainable architectural elements.
- **Packaging**: High-barrier films for food and medical applications.
- **Consumer Goods**: Recyclable or biodegradable electronics casings, sporting equipment, and furniture.

7 Sustainability and Open-Source Mandate

The development of Hempoxy is driven by a dual mandate: sustainability and open innovation. As a visionary entrepreneur in sustainable development and artificial intelligence, the author, Marie Seshat Landry, advocates for an "Organic Revolution of 2030," a movement to accelerate the adoption of sustainable, organic practices in alignment with UN Sustainable Development Goals.

Hempoxy is a direct contribution to this vision. By leveraging hemp, a renewable and carbon-sequestering resource, it reduces dependence on fossil-based fibers and resins. By disclosing the entire framework as prior art, this work prevents the formation of restrictive patents, ensuring that the technology remains accessible to researchers, entrepreneurs, and communities worldwide. This defensive publication is intended to foster a global, collaborative, and open-science approach to material innovation.

8 Conclusion

Hempoxy establishes a new paradigm in sustainable materials: nanosheet-reinforced epoxy composites that are strong, lightweight, tunable, and environmentally responsible. It builds upon existing research and industrial efforts in hemp-based materials, providing a clear classification and framework to guide future development. The variants, processing routes, and applications outlined herein are hereby released to the public domain as a defensive publication, ensuring universal and unrestricted access to this critical innovation.

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Zenodo Publications by Marie Seshat Landry

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HDCNS-Composites: Properties and Applications. Zenodo. DOI: 10.5281/zenodo.15084103

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