HEMPOXIES TECHNICAL BRIEF

FULLY BIO-BASED VITRIMER

PRE-EXPERIMENTAL — FOR LAB USE ONLY

Open-Sourced Specification
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Framework Stage: TRL 1–2 → Target TRL 9–10
Primary DOI: 10.5281/zenodo.19378380
Target Modulus: > 2.5 GPa (Tensile/Flexural)
Economic Platform: Minted Reserve Currency

1. Complete Recipe & Chemical Components

- **Epoxidized Hempseed Oil (EHO) [Bio-Matrix]:** Prepared via in situ peroxyformic acid epoxidation of cold-pressed hempseed oil (Iodine Value ≈ 150 g I_2/100 g). Serves as the primary polyepoxide backbone rich in linoleic/linolenic ester chains.
- **Sebacic Acid [Bio-Curative]:** Castor-derived dicarboxylic acid crosslinker. Carboxyl groups undergo epoxy ring-opening to yield dynamic β-hydroxy ester linkages.
- **Furfuryl Glycidyl Ether (FGE) [Reactive Diluent]:** Furan-derived monofunctional diluent; depresses precursor viscosity, enhances oxirane density, and eliminates VOC emissions.
- **Organosolv Hemp Lignin [Compatibilizer]:** Chemical bridge providing active -OH and epoxide moieties to bind hydrophobic EHO matrix with carbon fillers.
- **Zinc Acetylacetonate ($Zn(acac)_2$) [Transesterification Catalyst]:** Catalyst enabling dynamic bond exchange at elevated temperatures ($T > T_v$).
- **Hierarchical Hemp Carbon Reinforcement Phase:**
  - *Cellulose Nanocrystals (CNCs):* Acid-hydrolyzed hemp hurd (≈ 150 GPa axial modulus).
  - *Pyrolytic Biochar & Nanosheets:* Exfoliated hemp bast carbon providing structural integrity and thermal stabilization.

2. Stoichiometry & Exact Kinetic Calculations

- **Epoxide Equivalent Weight (EEW):**

EEW_{EHO} ≈ 258 g/eq (6.2% oxirane content)
EEW_{FGE} = 154.2 g/eq (Pure monoglycidyl furan)
EEW_{Blend} (85:15 oxirane molar ratio) ≈ 235 g/eq

- **Curative Ratio (Oxirane : Carboxyl = 1.0 : 1.0):**
  Sebacic Acid CEW = 101.1 g/eq (MW = 202.25 g/mol, difunctional)
  Stoichiometric Mass: 43.0 g Sebacic Acid per 100 g Resin Blend
- **Catalyst Loading & Kinetics:** 5.0 mol% $Zn(acac)_2$ relative to -COOH equivalents ensures fast topology relaxation time ($\tau^* < 100$ s at 180°C).
- **Nanofiller Loadings:** 2.0 wt% CNCs + 3.0 wt% biochar nanosheets homogenized via high-shear microfluidization prior to curing.

3. Green Organic Chemistry Principles

- **Atom Economy & Epoxidation:** In-situ peracetic/peroxyformic acid synthesis ($HCOOH + H_2O_2 \rightarrow HCO_3H + H_2O$) converts C=C bonds without halogenated reagents or organic solvent waste.
- **Dynamic Vitrimer Network Chemistry:** Curing yields abundant β-hydroxy ester linkages. At temperatures above topology freezing ($T_v \approx 150$°C), Zn^{2+}-catalyzed associative transesterification swaps covalent bonds rapidly without losing overall network integrity.
- **100% Renewably Sourced Biomass:** Completely eliminates Bisphenol A (BPA) and toxic aromatic amines (DDM, MDA), utilizing *Cannabis sativa L.* coproducts.
- **Closed-Loop Recyclability:** Full depolymerization achieved via catalytic glycol alcoholysis to recover carbon fillers and monoglyceride precursors intact.

4. Theoretical Performance Summary

Property Metric	Theoretical Target	Test Method
Tensile Modulus (E_c)	> 2.5 GPa	ASTM D638 / DMA
Glass Transition (T_g)	65°C – 95°C	DSC (10°C/min)
Topology Freezing (T_v)	150°C – 180°C	Rheometer (τ^*)
Healing Efficiency	> 85% (180°C, 30m)	Tensile Recovery
Thermal Stability ($T_{d5\%}$)	> 310°C	TGA (N_2)

5. Market Disruption & Minted Currency Vision

- **Market Advancement (TRL 1-2 → TRL 9-10):** Scaling from early hypothesis to pilot

manufacturing and commercial deployment in aerospace, automotive, and industrial composite sectors.

- **Minted Hempoxies Currency & Bullion:** Physical composite coins and bullion minted from carbon-negative Hempoxies grades. Sold on the open market as a tradeable, asset-backed material reserve currency for investors and traders to supply manufacturers in a circular economy.

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This document details an original hypothesis and pre-experimental formulation (TRL 1–2) open-sourced by **Marie-Soleil Seshat Landry** (marielandryspyshop.com). Formulations, stoichiometry, and kinetics represent scientific modeling and calculations. Perform laboratory experiments only under controlled engineering conditions with full safety protocols.