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INFLUENCE OF SALT-FOG EXPOSURE ON THE INTERFACIAL ADHESION BETWEEN FLAX FIBRES AND NOVEL BIO-BASED EPOXY MATRICES

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ABSTRACT
This work aims to investigate the adhesion between flax fibers and three different bio-based and recyclable epoxy systems, evaluating the impact of salt-fog spray exposure on interfacial resistance. Three epoxy monomers with varying biocarbon content were mixed with their respective curing agents. The compatibility of these systems with flax fibers was investigated under varying salt-fog exposure times. Mechanical characterization, conducted through short beam shear (SBS) tests, revealed differences in interfacial resistance among the epoxy systems used as the matrix.

INTRODUCTION
Biocomposites have garnered significant interest in recent years from both academia and various industries due to the growing environmental consciousness. Indeed, several researchers focused their attention on the use of natural fibers as alternative reinforcement of synthetic fibres and bio-based polymers to replace conventional plastics derived from oil. Furthermore, although epoxy resins are the most commonly used thermoset polymers as composite matrices, owing to their excellent thermal and mechanical properties, chemical inertia, and cost-effective processing, their primary drawback lies in the irreversibility of the curing reaction. Their cross-linked structure renders them infusible and insoluble, posing a significant challenge to the recycling of discarded composites. Consequently, there is active research into more eco-friendly recycling routes for epoxy-based composites, beyond incineration and/or landfilling, to minimize their environmental impact (Oliveux al, 2015).
A further issue with these composites is their generally lower mechanical performance compared to their synthetic counterparts. This is primarily attributed to the weak adhesion between the hydrophilic natural fibers and the hydrophobic matrices. In such a context, the quantitative evaluation of the fiber/matrix interface is critical in designing biocomposites.
To address the need for more sustainable epoxy matrices (both bio-based and potentially recyclable) and simultaneously evaluate their compatibility with natural fibers, this paper investigates the adhesion between flax fibers and three innovative epoxy systems using short beam shear tests.
In more detail, all the used epoxy prepolymers (i.e., Polar Bear, Green Turtle, and Plankton) were supplied by R*Concept. Polar Bear, with a bio-carbon content exceeding 28%, was mixed with its recyclable hardener Recyclamine™ R101 (100:22 by weight). This hardener, containing a cleavable ketal group, enables the full recyclability of the cured resin (Dattilo, 2022). Green Turtle, exhibiting a bio-carbon content greater than 40%, was also mixed with Recyclamine™ R101 (100:22) to obtain a recyclable system with a higher bio-based content. The prepolymer Plankton possesses the highest bio-carbon content (>77%), but our preliminary tests revealed that it required mixing with its non-recyclable hardener (100:30).
Six layers of flax bidirectional twill fabric (areal weight 318 g/m²), supplied by Lineo, were used as reinforcement for short beam shear (SBS) specimens (40 x 20 x 4 mm3). Five samples were manufactured for each epoxy matrix and aging condition. The curing process involved a 24-hour cure at 25°C under vacuum, followed by post-curing. For the Polar Bear system, post-curing was conducted at 100 °C for 3 hours, while the Green Turtle and Plankton systems were post-cured at 80 °C for 4 hours.
The impact of aging on the fiber-matrix adhesion was evaluated by exposing SBS specimens to salt fog (5 wt.% NaCl) at 35 °C ± 1 °C for up to 3 months in a climate chamber model CC1000IP by Ascott, according to ASTM B117. Single sets of specimens for mechanical characterization were removed from the climatic chamber and tested after 30, 60, and 90 days. Unaged specimens were also tested as reference.
SBS tests were conducted in displacement control mode using a Zwick/Roell universal testing machine (UTM) model Z005, equipped with a 5 kN load cell, following the ASTM D2344 standard. The support span and crosshead speed were set to 16 mm and 1 mm/min, respectively.

RESULTS AND CONCLUSIONS

The effect of salt-fog exposure on the interfacial resistance of flax fibers with three novel bio-based epoxy resins was evaluated in this work. To this end, SBS tests were conducted every 30 days of aging, up to a total of 3 months. The mechanical results were analyzed together with morphological analysis to highlight the effect of matrix degradation on maintaining adhesion with the fibers. However, Green Turtle exhibited a performance reduction comparable to the other systems, despite its high biocarbon content. Additionally, this epoxy system is recyclable, making it a promising candidate for sustainable material applications. Overall, all bio-based matrices demonstrated good compatibility with flax in marine environments, suggesting their high applicability as replacements for fossil-based epoxy resins. This aligns with the goals of eco-sustainability and the circular economy.

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REFERENCES

[1] Oliveux G, Dandy LO, Leeke GA. Current status of recycling of fibre reinforced polymers: Review of technologies, reuse and resulting properties. Prog Mater Sci, 2015, 72, p. 61-99.
[2] Dattilo S, Cicala G, Riccobene PM, Puglisi C., Saitta L. Full Recycling and re-use of bio-based epoxy thermosets: Chemical and thermomechanical characterization of the recycled matrices. Polymers, 2022, 14, 4828.