Materials and structures

62490 Characterization of novel sustainable composite materials based on Elium® 188 O resin reinforced with a Colombian natural fiber

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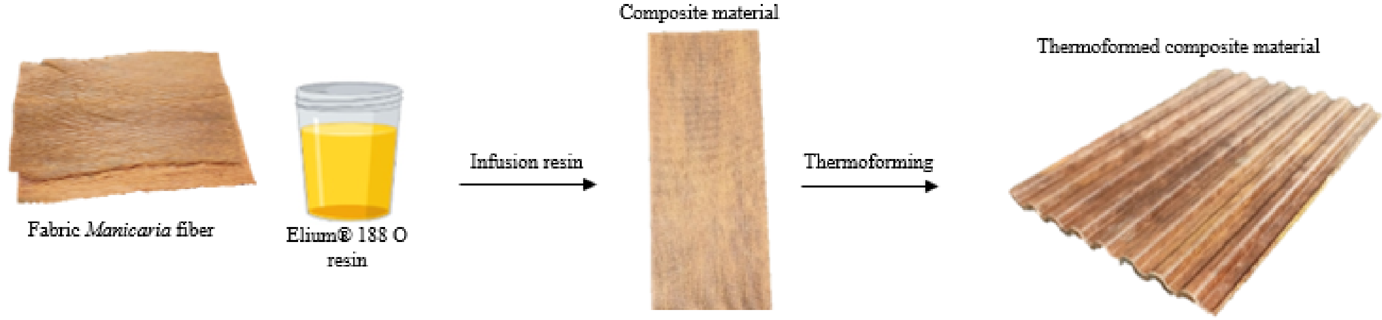
In this work, physical, thermal, and mechanical characterization of novel composite materials based on Elium 188® O resin, a liquid thermoplastic resin catalyzed with Luperox® AFR40, reinforced with natural fiber fabric extracted from the Manicaria Saccifera palm, produced in Chocó region of Colombia, was carried out. A vacuum-assisted resin infusion (VARI) manufacturing methodology was proposed to develop the composite materials using processed and chemically treated Manicaria fiber. The influence of the presence of reinforcement and its orientation in [0]s, [90]s, and [0/90] configurations was studied. The density (ASTM D792), moisture content (ASTM D6980), and water absorption (ASTM D570) of the materials in contrast with catalyzed resin were determined. The volumetric fiber and void content (ASTM D2734) were also measured. Thermal stability was evaluated by TGA analysis and glass transition by DSC technique. Resin and composites were characterized under tensile (ASTM D639 and ASTM D3039), flexure (ASTM D790), and Izod impact (ASTM D256) tests. Physical characterization showed that fiber orientation does not produce variations in density, but its presence does (1.18 g/cm3 for the resin and 1.21 g/cm3 for the composites). The moisture content in the composites was not significantly different than resin, and the water absorption increased from 0.19% to 1.85% due to the presence of Manicaria fiber. For all composites, the fiber volume fraction was 0.23, and the void content was 3.9%. Thermal analysis showed that the degradation process of the composites started in the same temperature range as the resin due to the similar thermal stability of Manicaria. The glass transition was located at 120°C for the composites and 80°C for the matrix. Mechanical tests showed that the properties of the resin improved, but they depend on the fiber configuration in the material. In the material with the best properties, [0]s composite, tensile stress (64 MPa), Young's modulus (4.5 GPa), flexural stress (90 MPa), flexural modulus (3.21 GPa), and impact strength (13.5 kJ/m2) improved by 60%, 61%, 41%, 66%, and 22%, respectively. The [90]s and [0/90] composites showed a decrease in tensile stress and impact strength, but they improved the Young's modulus and flexural modulus compared to resin. The [0/90] composite also improved the flexural stress by 36%. Finally, thermoforming was tested on the [0]s composite using a compression mold at 160°C and 15 bar. A corrugated structure with a good surface finish was obtained, demonstrating that the composite materials studied could be mechanically recycled, sustainable, and used in engineering applications. In summary, the improvements in the thermal properties and differences in the mechanical properties of the composites showed that the presence and the orientation of the reinforcement have a statistically significant influence, and Manicaria fiber has good potential as a reinforcement for composite materials.



Properties	Resin	[0]s	[90]s	[0/90]
Density [g/cm^3]	1.18 ± 0.01	1.21 ± 0.01	1.21 ± 0.01	1.21 ± 0.01
Moisture content [%]	0.08 ± 0.03	0.11 ± 0.01	0.11 ± 0.01	0.11 ± 0.03
Water absorption [%]	0.19 ± 0.03	1.50 ± 0.18	1.85 ± 0.10	1.68 ± 0.15
Tensile stress [MPa]	39.52 ± 3.07	63.45 ± 3.21	13.45 ± 0.84	20.37 ± 2.65
Young's modulus [GPa]	2.80 ± 0.19	4.52 ± 0.48	2.94 ± 0.36	4.42 ± 0.24
Tensile strain [%]	2.06 ± 0.32	1.92 ± 0.24	0.51 ± 0.05	0.56 ± 0.27
Flexural stress [MPa]	64.09 ± 4.50	90.39 ± 2.48	30.00 ± 2.70	87.28 ± 1.94
Flexural modulus [GPa]	1.94 ± 0.15	3.21 ± 0.21	2.33 ± 0.03	2.49 ± 0.18
Flexural strain [%]	5.14 ± 0.73	3.19 ± 0.23	1.39 ± 0.14	4.40 ± 0.68
Impact strength [kJ/m^2]	10.97 ± 0.75	13.38 ± 0.78	2.46 ± 0.13	4.68 ± 0.55

keywords: Manicaria fiber, characterization, novel sustainable composite, Elium® 188 O resin, infusion resin, thermoforming