Rosin and Its Derivatives: a sustainable approach for automotive applications

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Plastics are widely used today, but their dependence on fossil fuels raises significant sustainability concerns, reinforcing the need for bio-based alternatives. Nature provides renewable raw materials with promising properties, valued for their availability, environmental benefits, and ease of modification.

The RN21 project is leading research into natural pine resin as a renewable resource, with a particular focus on rosin derivatives (UP). It aims meet the growing demand across various sectors - including automotive industry - for durable and environmentally friendly materials. By incorporating bio-based alternatives, this initiative supports sustainability and helps pave the way for greener industrial solutions.

This study explores the integration of rosin derivatives into bio-based polymers, targeting applications in automotive interior parts. The work encompasses material formulation, compounding and processing, followed by evaluation of mechanical, thermal, rheological and density properties. The goal is to achieve high performance, sustainable materials that meet the automotive industry's technical standards, ensuring optimal strength, processability and compatibility with current manufacturing processes. andards, ensuring optimal strength, processability and compatibility with current manufacturing processes. A preliminary Life Cycle Assessment (LCA) analysis has been conducted to compare the environmental impact of rosin-based biopolymers with petroleum-based counterparts commonly used in such applications.

Keywords: Rosin resin derivatives, eco-friendly polymers, compounding, material characterisation, automotive applications.

MAIN RESULTS

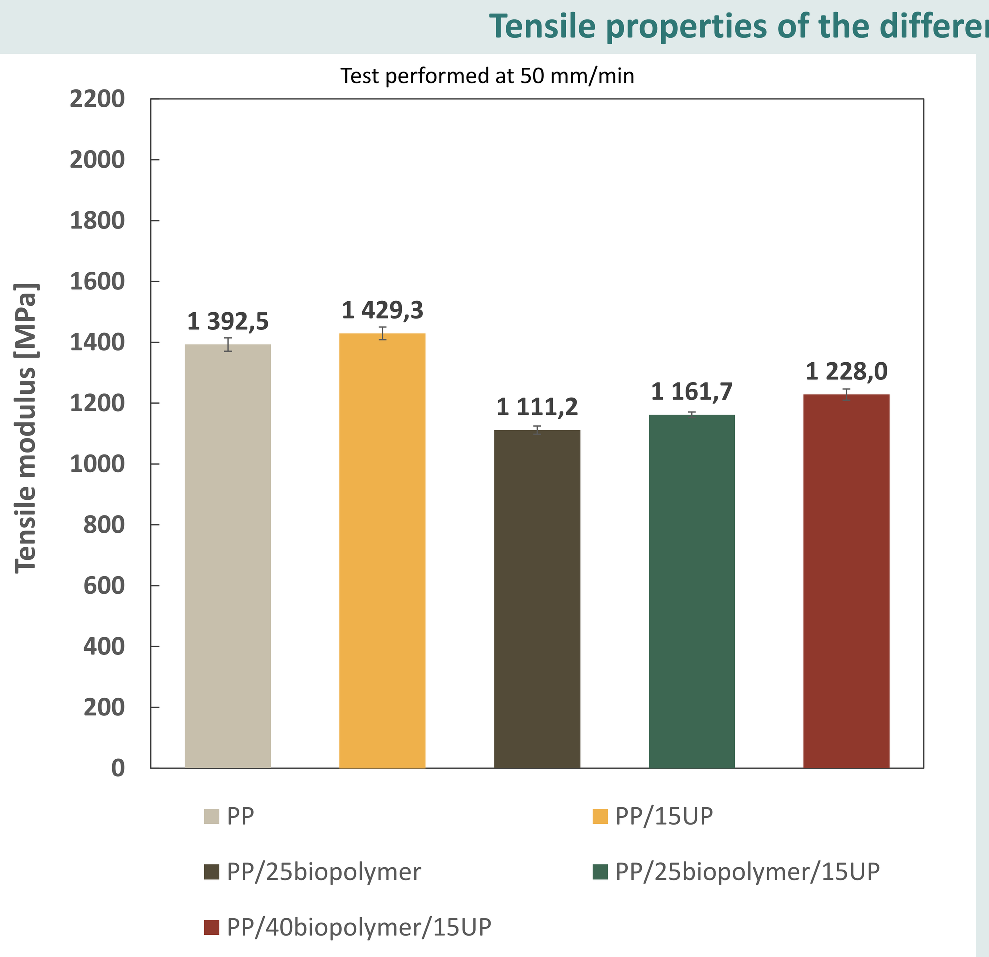
TGA and DSC results of virgin polymers and gum rosin compounds

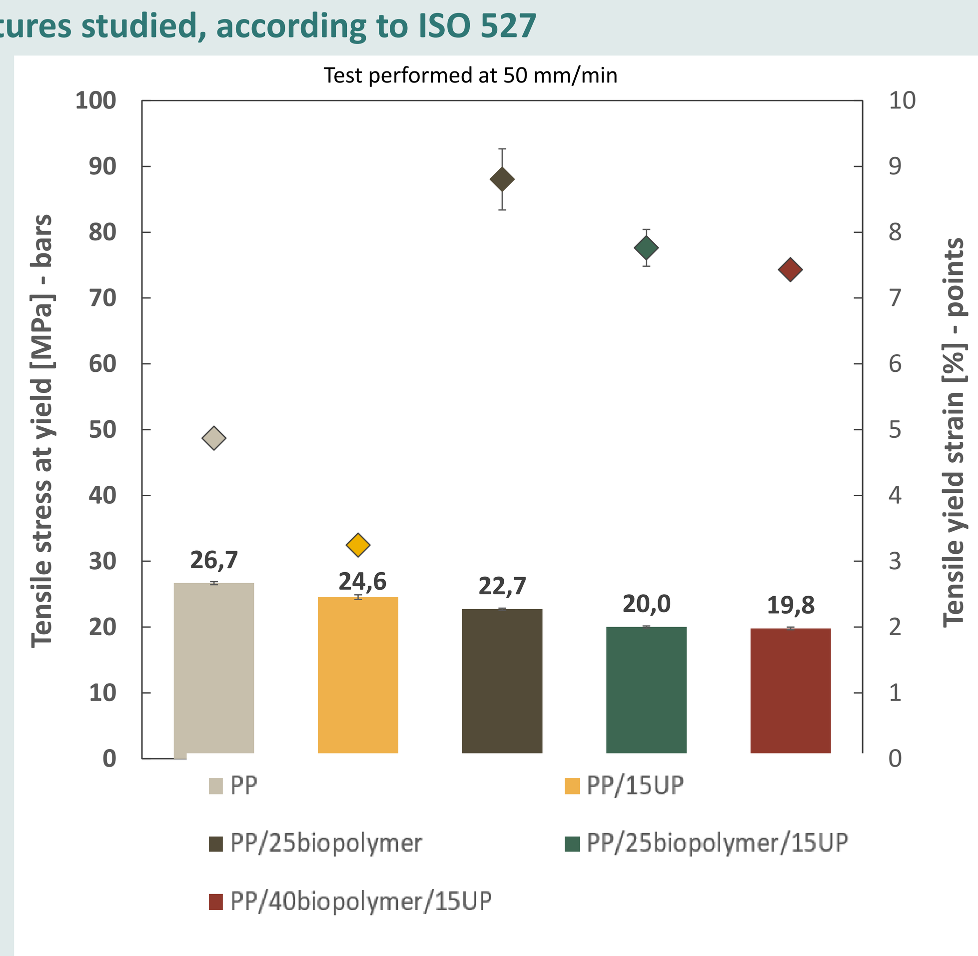
	Onset T_d [˚C]	T_m [˚C]	ΔH_m [J/g]	T_c [˚C]	ΔH_c [J/g]	X_c [%]
PP	401.9 ± 5.1	164.4 ± 0.2	109.9 ± 0.5	122.0 ± 0.1	-113.3 ± 0.3	53.9 ± 0.3
PP/15UP	420.1 ± 4.6	164.3 ± 0.1	86.9 ± 3.2	118.2 ± 0.2	-92.3 ± 3.8	50.1 ± 1.8
PP/25biopolymer	397.6 ± 2.1	164.4 ± 0.1	55.3 ± 0.4	121.2 ± 0.1	-148.0 ± 1.5	36.2 ± 0.2
PP/25biopolymer/15UP	425.1 ± 0.3	162.3 ± 0.3	45.4 ± 0.6	-	-133.9 ± 3.2	37.1 ± 0.5
PP/40biopolymer/15UP	425.7 ± 4.3	162.1 ± 0.0	39.4 ± 0.8	-	-127.2 ± 4.2	43.0 ±0.9

MFI and density results of virgin polymers and gum rosin compounds

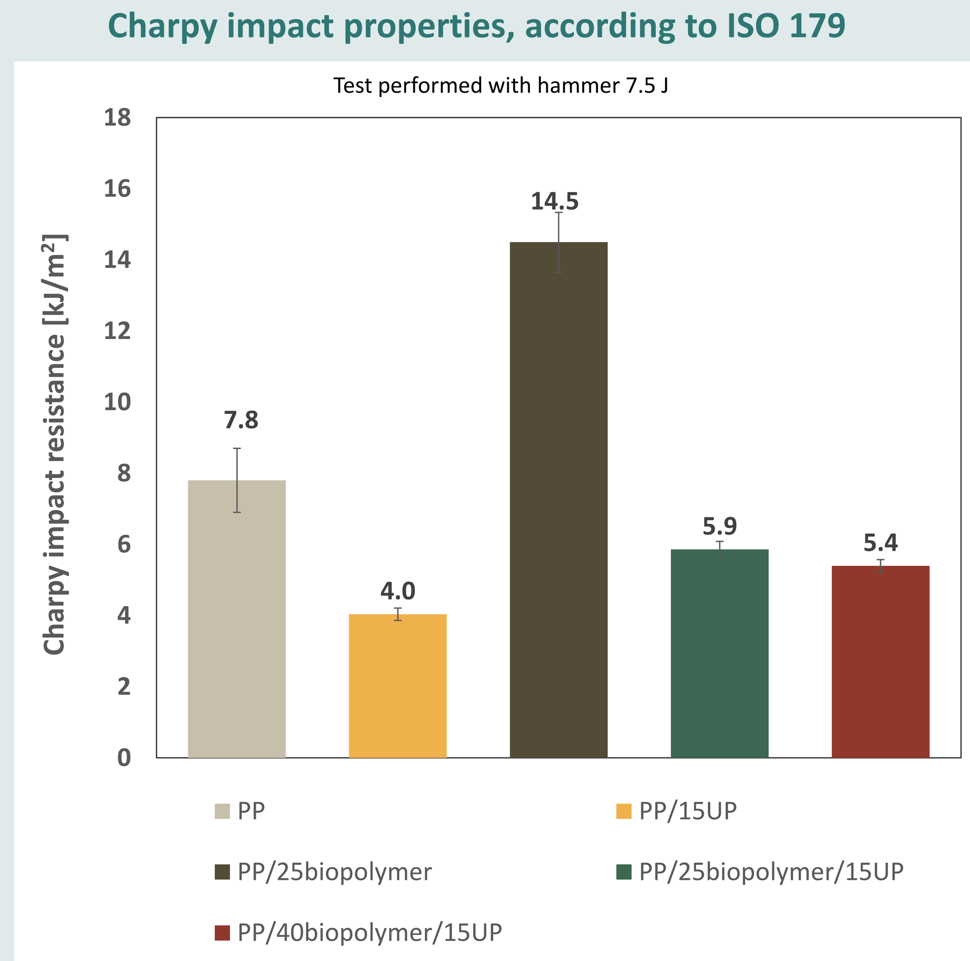
	MFI [g/10 min]	Density [g/cm³]
PP	10.99 ± 0.53	0.92 ± 0.01
Biopolymer	7.98 ± 0.59	0.93 ± 0.01
PP/15UP	13.23 ± 0.77	0.93 ± 0.00
PP/25biopolymer	8.96 ± 0.11	0.93 ± 0.01
PP/25biopolymer/15UP	11.73 ± 0.35	0.95 ± 0.00
PP/40biopolymer/15UP	10.25 ± 0.16	0.95 ± 0.01

Tensile properties of the different mixtures studied, according to ISO 527

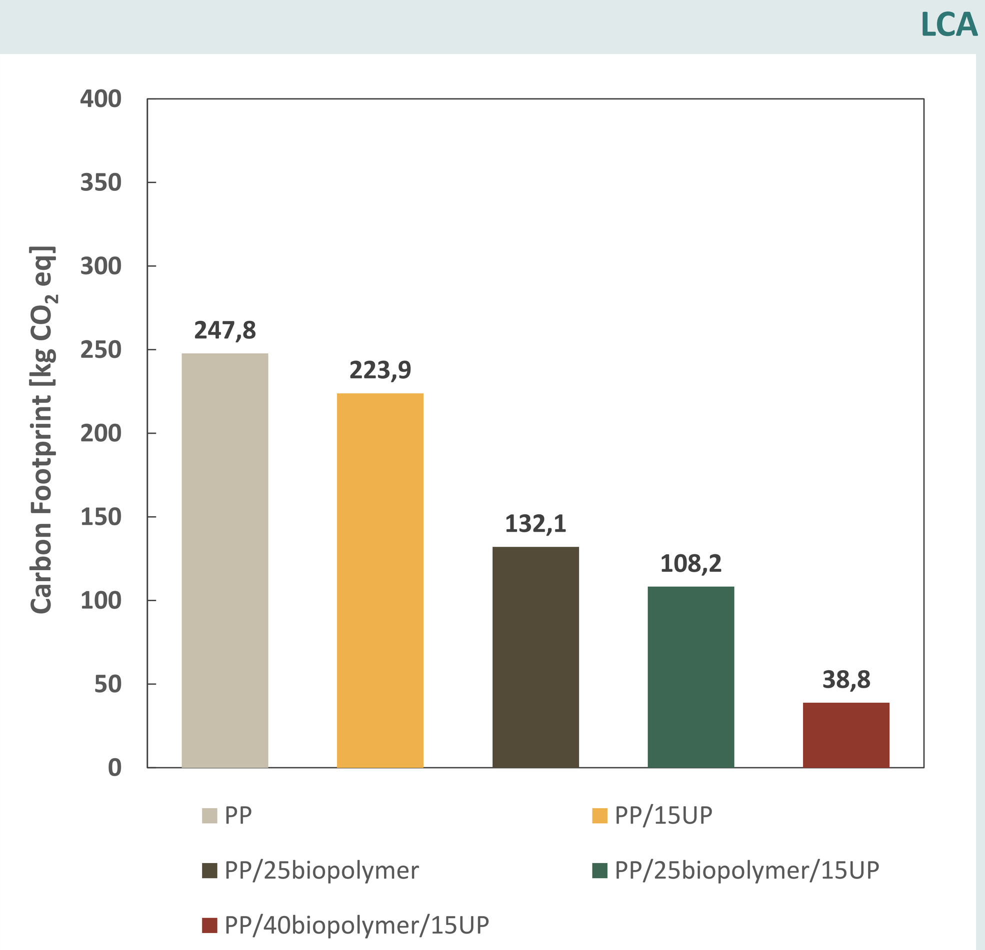


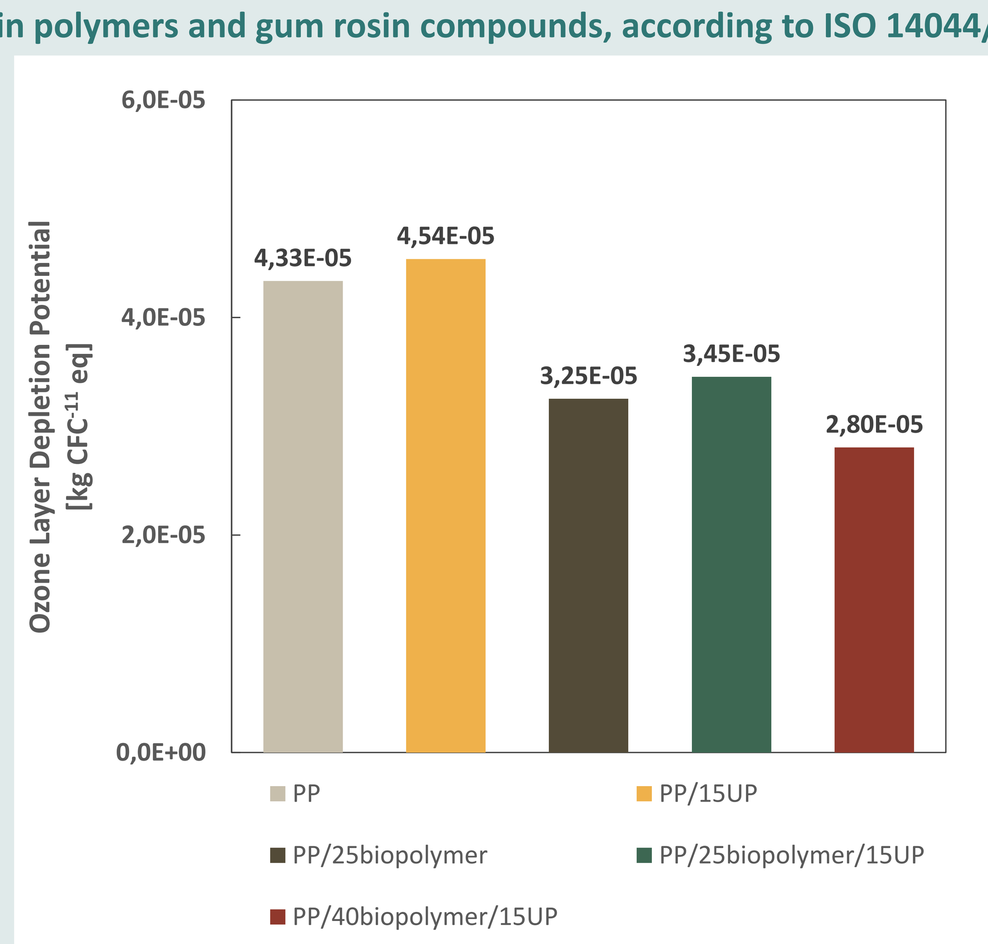


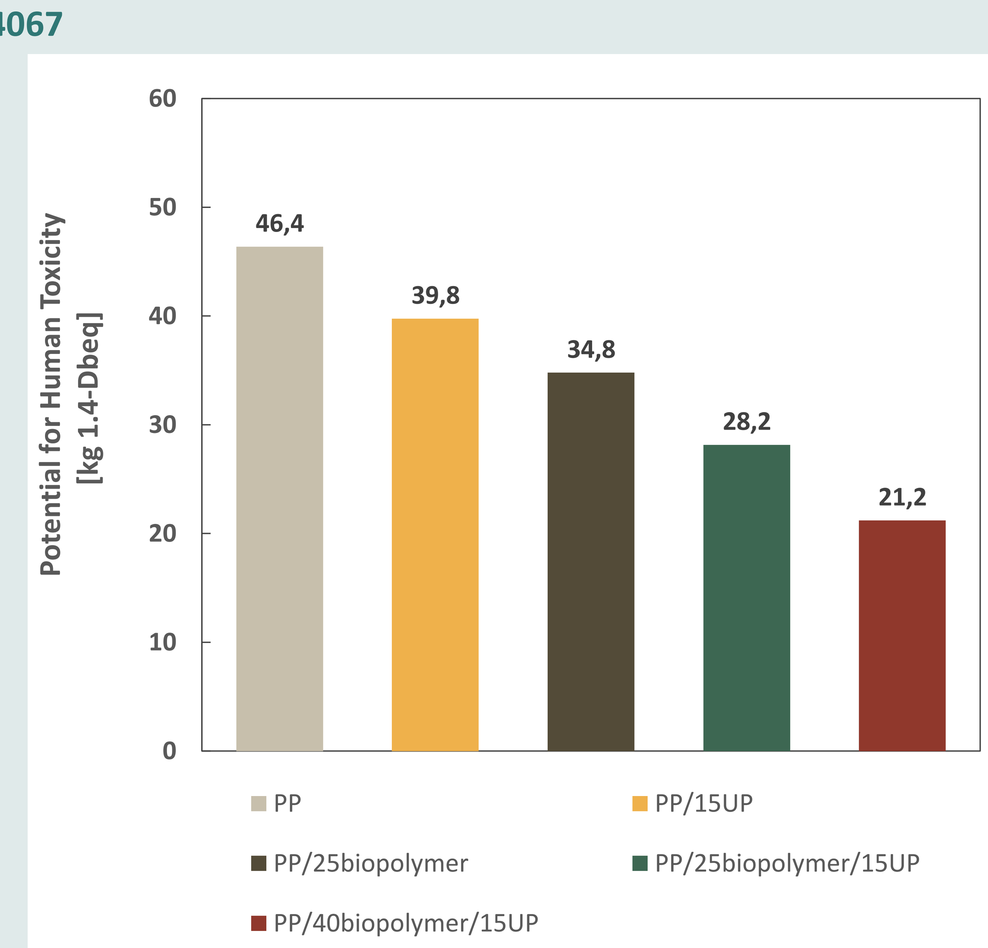
Charpy impact properties, according to ISO 179



LCA of virgin polymers and gum rosin compounds, according to ISO 14044/ISO 14067







FINAL REMARKS

- **Thermal Properties**: Decreases in crystallization (T_c) and melting (T_m) temperatures indicate modified crystalline structure and improved amorphous stability. Higher onset degradation temperature (onset T_d) reflects enhanced thermal stability with UP addition.
- **Mechanical Performance**: UP modifies melt flow behaviour and density, slightly reducing Charpy impact resistance, while maintaining robust mechanical performance across biopolymer content variations (25–40 % w/w). Bio-based polymer inclusion offsets some mechanical losses, improving impact resistance, and slightly reducing tensile modulus.
- **Environmental Sustainability**: UP addition reduces carbon footprint and human toxicity indicators, although it slightly increases ozone layer depletion. Bio-based polymer mitigates this trade-off. Blends achieve up to 55 % (w/w) bio-based content, supporting environmental sustainability goals.
- **Application Potential**: PP/biopolymer/UP blends demonstrate a promising sustainable solution, combining thermal and mechanical properties suitable for automotive applications.

Injection-Moulded Automotive Component Based on PP/25Biopolymer/15UP Composite

Partners

Financed by

The authors acknowledge the financial support from integrated project RN21 (TC-C12-i01, Sustainable Bioeconomy No. 02/C12-i01.01/2022), promoted by the Recovery and Resilience Plan (RRP), Next Generation EU, for the period 2021-2026.