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Performance of alternative biowax powders replacing PTFE fillers in bio-based epoxy coatings

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INTRODUCTION & AIM

In view of sustainable development and reducing carbon footprint in the coatings industry, the performance and sustainability of protective coatings should be enhanced by the incorporation of bio-based additives. The environmentally harmful products such as PTFE are frequently used because of their versatility and combination of unique properties providing hydrophobicity, chemical resistance, thermal stability, non-stick properties, scratch resistance, dry lubrication, and abrasion protection.

In this study, the role of micronized biowaxes of different origin and sizes is evaluated when added in 0.5 to 10 wt.-% concentration ranges as micropowder additives in an epoxy coating. With potential applications a wood protective coatings, the mechanical and physical properties are evaluated and benchmarked against a micronized synthetic wax powder, PTFE powders and their mixtures. For better understanding on the protective roles of biowaxes, additional analysis of the surface properties by infrared spectroscopy is presented oni the native and worn coatings. The presented data may contribute to a more dedicate selection for PTFE alternatives in coatings with equal performance.

METHOD

The epoxy resin coating consists of an epoxidized flaxseed oil (Component A), and proprietary hardener mix comprising bio-based aliphatic organic acids and esters (Component B), as obtained from Orineo BV (Kortenberg, Belgium).

The different micronized wax powder additives (Table 1, Figure 1), including biowaxes, mixed fossil-based waxes with proprietary ratio of synthetic PE wax versus PTFE, and the reference wax powders of synthetic PE wax and PTFE, were obtained from Shamrock Technologies (Tongeren, Belgium).

Table 1. Micronized wax powders used as additives in epoxy coating formulations

Micropowder acronym	Wax type	Powder size range (µm)	Melting temperature (°C)
CBW-5	Carnauba biowax	4 – 6	82 – 86
CBW-9	Carnauba biowax	8 – 11	82 – 86
RBW-5	Rice bran biowax	4 – 6	78 – 82
RBW-9	Rice bran biowax	8 – 11	78 – 82
ABW-5	Stearamide biowax	3.5 – 5.5	142
PW-5	PE wax/PTFE	5	58 – 60
PW-9	PE wax/PTFE	9	58 – 60
PTFE	PTFE	7	(> 300)
PE	PE wax	7	110

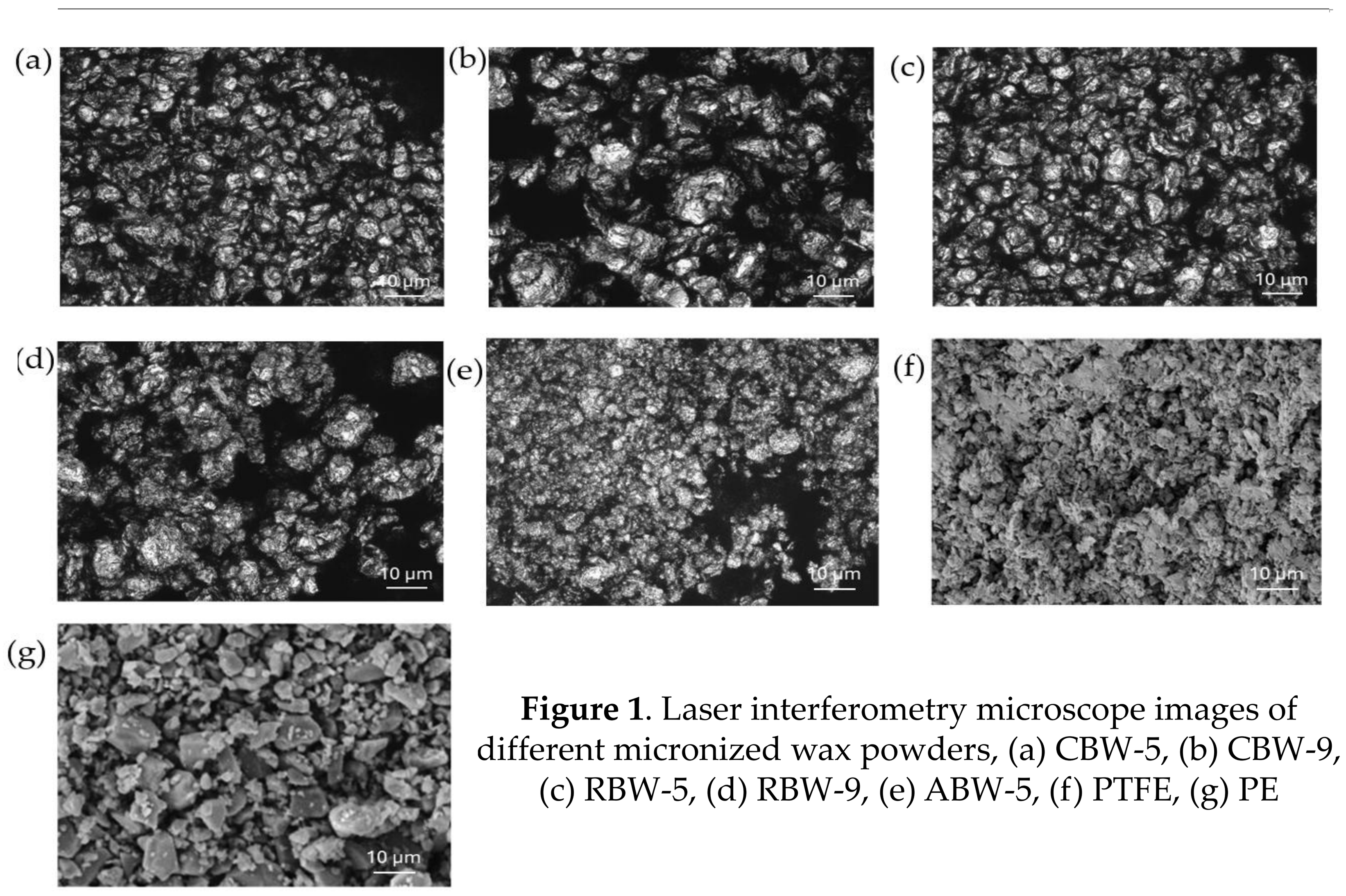

Figure 1. Laser interferometry microscope images of different micronized wax powders, (a) CBW-5, (b) CBW-9, (c) RBW-5, (d) RBW-9, (e) ABW-5, (f) PTFE, (g) PE

RESULTS & DISCUSSION

The effect of different types and concentrations of micronized wax powders on mechanical and protective properties of the epoxy coatings on wood was evaluated by abrasive wear testing, hardness measurements and scratching resistance testing (Figure 2).

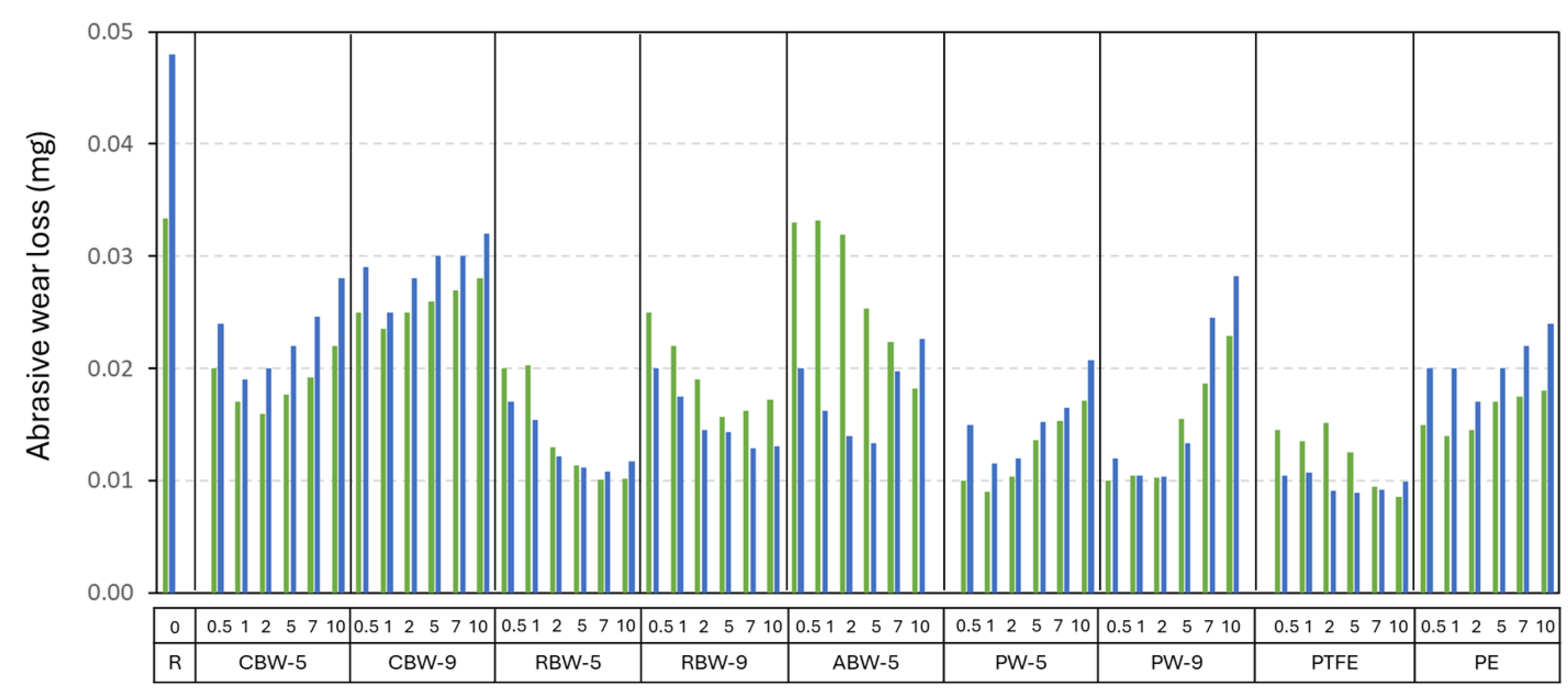

Figure 2. Abrasive wear loss of epoxy coatings with different micronized wax types and concentrations (0.5, 1, 2, 5, 7, 10 wt.-%), under low loads (250 g, green bars), and high loads (500 g, blue bars).

The water repellence of epoxy coating formulations with different types of micronized waxes is characterized by static water contact angles measured before and after abrasive wear testing, as presented in Figure 3. Allover, the coatings with micronized biowax present a higher hydrophobicity as compared to the synthetic waxes and reference PTFE or PE wax, and introduce the highest water contact angles mainly for the smallest powder sizes. After exposure of the wax in combination with the changes in surface roughness within the abrasive wear track, the hydrophobicity of worn coatings is significantly enhanced and protection against water remains particularly existing in presence of biowax micropowders.

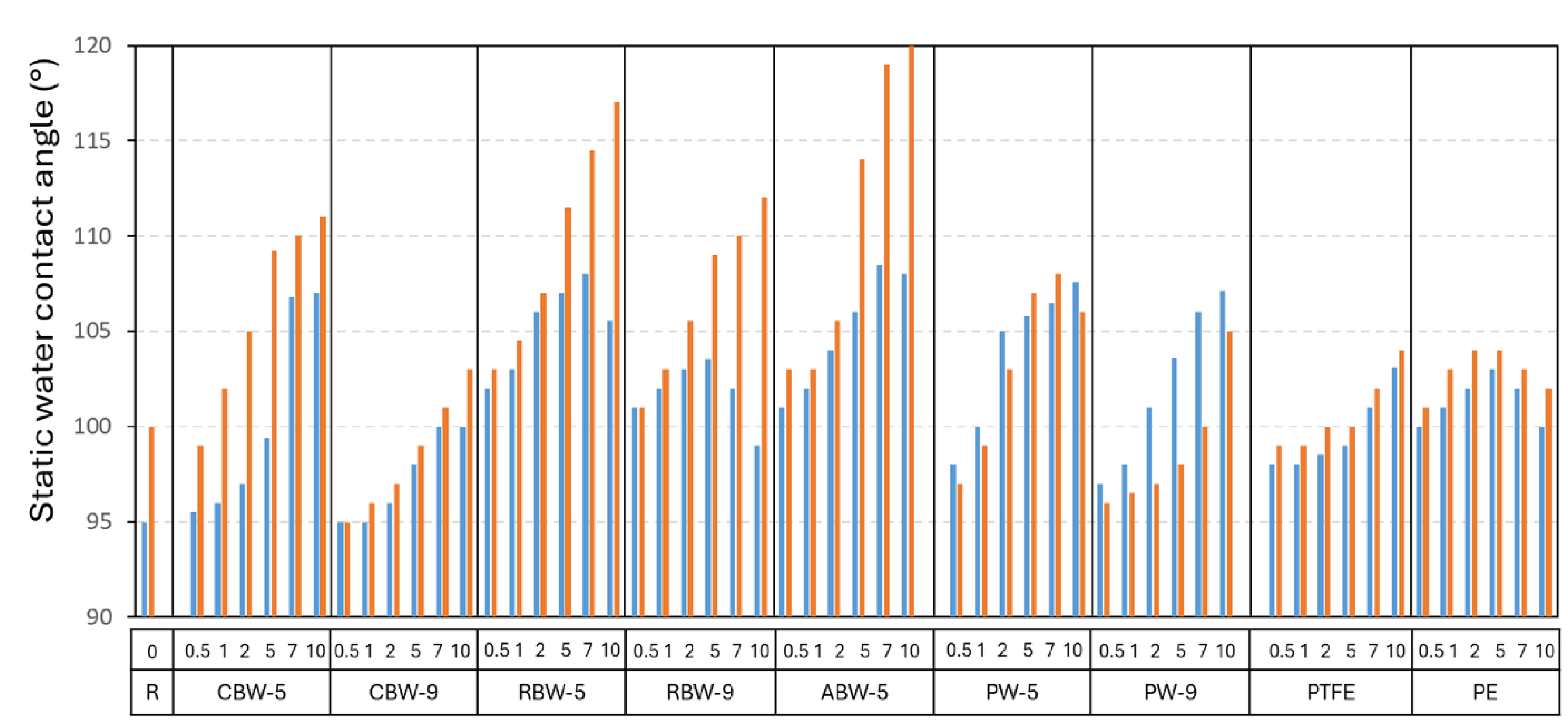

Figure 3. Water contact angles of epoxy coatings with different micronized wax types and concentrations (0.5, 1, 2, 5, 7, 10 wt.-%), measured on the coatings before wear (blue bars), and after wear under highest load (orange bars).

CONCLUSION

- Similar abrasive wear resistance for biowax types as compared to PTFE.
- Rice bran micropowders provide lower wear than carnauba micropowders and stabilized wear loss under both low and high loads at higher wax concentrations. The small particles are more effective than the large particle sizes. Based on mechanical coating properties.
- Good potential for replacing PTFE additives by rice bran wax based on comparable abrasive wear, hardness, scratch resistance and hydrophobicity.