Development of a Green Formulation for Particle Boards Using Epoxidized Natural Rubber Latex

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Dissertation

Submitted in Partial Fulfilment of the Requirements for the Bachelor of Science (Honours) Degree in Chemistry

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The Open University of Sri Lanka

2025

ABSTRACT

Formaldehyde emissions from conventional particle boards present serious health and environmental concerns, necessitating the development of low-emission, bio-based alternatives. This study investigates the use of epoxidized natural rubber (ENR) as a sustainable adhesive in combination with urea-formaldehyde, sawdust, coconut shell powder, and commercial epoxy-binder system for the production of particle boards. Boards were fabricated under optimized temperature and pressure conditions, and their properties were assessed through physical, mechanical, and chemical analyses.

Densities of the boards ranged from 0.440 g/cm^3 to 2.383 g/cm^3, reflecting the variation in filler composition and adhesive content. Tensile strength values ranged from 11 N to 286 N, with higher strength observed in coconut shell powder-based formulations compared to sawdust. Thickness swelling and water absorption indicated improved dimensional stability among the samples. The moisture content remained below 24% in all boards, with lower values in coconut shell-enriched samples.

Formaldehyde emission levels ranged from 0.0 ppm to 17.3 ppm, with several samples satisfying, satisfying international standards for low-emission boards (e.g., JIS A1460-2001, GB/T9846.3-2004). FTIR spectroscopy confirmed the chemical functionality of ENR, revealing prominent peaks for –OH stretching, epoxy groups, C=O, and C–O–C vibrations. A decrease in carbonyl band intensity with reduced UF content supported the observed reduction in formaldehyde emission. FTIR also verified the incorporation of coconut shell powder and its interaction with ENR and starch, correlating with enhanced board performance.

These results demonstrate the potential of ENR-based adhesives in formulating low-emission, eco-friendly particle boards with acceptable strength and water resistance, offering a promising alternative to formaldehyde-based systems.