Siloxylated Lignin Coatings for Enhanced Water and Oil Barrier Applications

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Abstract

Molded fiber products have poor resistance to water and oil, a challenge that is usually addressed by coating the surface with per-and polyfluoroalkyl substances. Bio-based and eco-friendly coatings offer a promising alternative to per-and polyfluoroalkyl substances (PFAS) in molded fiber products. PFAS materials have excellent water and oil barrier properties but are being phased out due to their impact on the environment and human health. The objective of this research is to develop an eco-friendly coating derived from biomass. Lignin, a renewable polyphenolic macromolecule that constitutes 15% to 30% of biomass, stands out as a sustainable polymer due to its inherent hydrophobicity. Lignin sourced from softwood, hardwood, and grasses were selected as the base material due to its hydrophobicity and was functionalized using methyltrimethoxysilane (MTMS) to enhance its oil resistance. Thermoformed fiber sheets were coated with the silanized lignin and characterized by contact angle goniometry and tensile tests. The water and oil contact angle of modified lignin coated thermoformed fiber sheets was to 120° and 75°, respectively, while the Young's modulus increased by 78% and tensile strength increased by 81%. The characterization of the resulting materials demonstrated significant

improvement in water and oil repellency, mechanical strength, and barrier properties compared to unmodified lignin. These findings highlight the potential of lignin-based coating as a high performance, sustainable solution for packaging applications.