Tuning the thermoplasticity of recycled wastepaper films for fully biobased flexible food packaging

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Abstract

Biobased and functional packaging sourced from renewable carbon sources, such as mixed wastepaper, holds promise as an eco-friendly and non-hazardous substitute for plastics. However, the thermo-processability of bio-based packaging often fall short for practical use, specifically in multi-layer and flexible food packaging. To address this challenge, a new approach is proposed to synthesize flexible cellulosic packaging from wastepaper that leverages microwave irradiation and ionic liquids-based wet film casting technology. Ground mixed wastepaper was first dissolved in 1-ethyl-3-methylimidazolium acetate via optimized microwave irradiation conditions, namely the paper concentration (5% and 10% w/w) and duration (3, 6, and 12 min). The resulting ionogel was cast into thin films of 0.08 mm thickness using an automated flatbed system and regenerated using water as the anti-solvent. The thermoplasticity of the regenerated films were tuned by varying the concentration of residual ionic liquid and demonstrated using dynamic mechanical analysis. Conversely, the mechanical properties, namely Young's modulus and elongation at break, of the regenerated films were found to be inversely proportional to the residual ionic liquid content. Future experiments will examine the vacuum forming, oxygen permeability, and water vapor transmission rate of the regenerated films to evaluate their potential for fresh food packaging. By recycling wastepaper via a "green" manufacturing technology, our research produces a thermoplastic cellulosic film which could be a promising solution to fully bio-based flexible food packaging.