Delamination Techniques for Sustainable Packaging: A Focus on Multilayer Aluminum-Based Food Packaging

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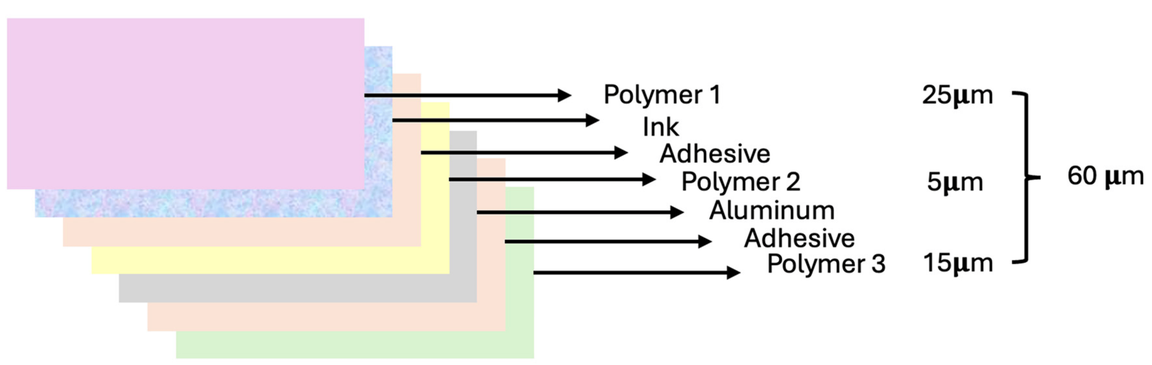
Introduction

Sustainable packaging management is key in our environmentally conscious society. Multilayer aluminum-based food packaging, while excellent for preserving freshness, poses recycling challenges due to its bonded layers. This study focuses on delamination techniques, which separate these layers into recyclable components. We aim to explore the structural properties of these packaging materials and evaluate the feasibility of separation. By addressing the challenge of dismantling complex structures, this research seeks to reduce waste and environmental impact, contributing to sustainable practices and promoting a circular economy.

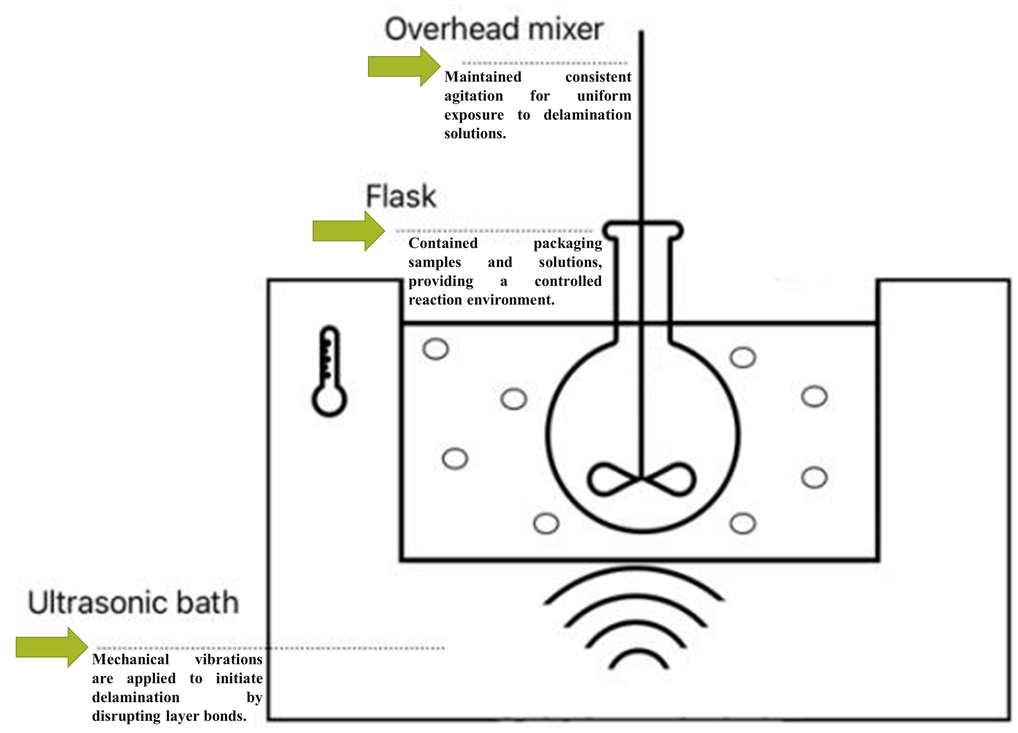


Structure of multilayer food packaging based on research results

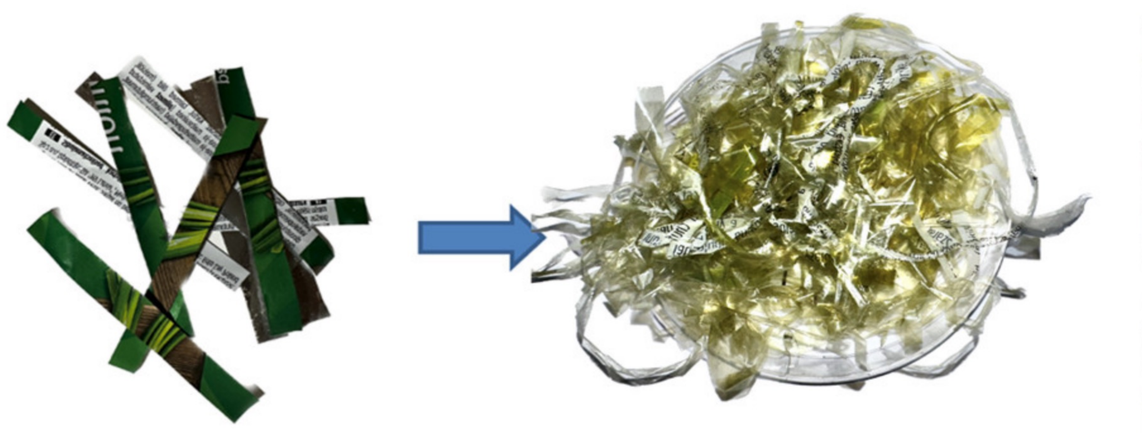
Methodology

The delamination process utilized a laboratory-scale reactor with critical components: an ultrasonic bath, flask, and overhead stirrer. Multilayer aluminum-based food packaging samples underwent experiments using three delamination solutions: nitric acid, lactic acid, and a lactic acid/choline chloride mix.

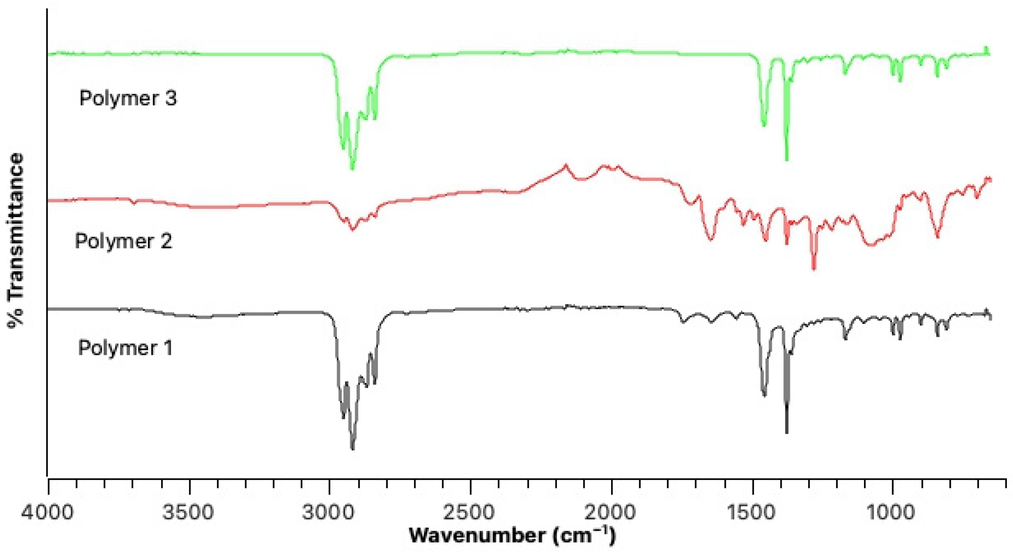
experiments were meticulously designed, optimizing conditions for effective layer separation. Results promise to enhance recycling capabilities and promote sustainability in the food packaging industry.



A laboratory-scale reactor was utilized in the study.



Packaging before delamination and after delamination, based on research results.



FTIR spectra of recovered polymers from multilayer packaging.

Results & Discussion

Experiments on multilayer packaging films yielded mixed results. A detailed study on various chemical agents for layer separation revealed that nitric acid effectively disintegrated the layers but damaged aluminum, adhesives, and dyes. Lactic acid, used alone or with choline chloride, was better at separating aluminum without these issues, but could not separate polymer layers, and printing remained intact. While lactic acid left a tough-to-remove oily residue, nitric acid facilitated easier purification due to its water solubility. Thus, while each acid has its drawbacks, nitric acid's purification benefits underscore the complexity of delaminating multilayer packaging and point to the need for more research.

Conclusion

This study investigated delamination techniques for enhancing the recyclability of multilayer aluminum-based food packaging. Nitric acid effectively separated layers but caused aluminum dissolution issues. Lactic acid, with or without choline chloride, showed promise in disassembling aluminum components. However, persistent challenges included interconnected polymer layers and stubborn residue. Despite this, nitric acid offered more efficient purification due to its higher water solubility. These findings underscore the complexity of delamination and highlight the need for further research to develop effective recycling methods while addressing residue challenges, contributing to sustainable packaging practices.

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