Demonstrating the Potential of Recycled Polyurethane Mattress Foam in Footwear Applications

Executive Summary

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Introduction

As mattress recycling continues to grow nationwide, there is a need for additional secondary markets for post-consumer polyurethane (PU) mattress foam beyond carpet rebond pad. Here, we report on a Mattress Recycling Council (MRC) sponsored research project to develop and evaluate two pathways for recycling PU mattress foam into functional materials for footwear. Specifically, we explored how post-consumer recycled PU mattress foam can be incorporated into both cushioning midsoles and high-traction outsoles, enabling possible commercial uses for the recycled foam and a practical circular economy approach for the footwear industry,

Recycling flexible PU foam can be challenging due to its cross-linked structure and low density. However, recent work has demonstrated the potential of relying on the vitrimeric properties (ability to break and re-form crosslinking bonds) to re-purpose thermoset PU foam. Relying on this approach, this project established two viable recycling routes. These pathways enabled the production of midsole-grade blends and outsole-grade composites that incorporate recycled content while maintaining the comfort, durability, and traction required for footwear applications.

Key Accomplishments.

Midsole Material Development and Testing

Blends of Thermoplastic Urethane (TPU) and recycled PU were produced at multiple ratios up to 50% recycled content and evaluated under cyclic compression testing to quantify damping behavior, residual strain, and energy absorption, all important parameters for footwear midsoles. The results showed that recycled content can be used to adjust cushioning characteristics, while maintaining stable performance under repeated loading. These findings demonstrate that recycled foam can serve as a design lever for tailoring midsole feel and responsiveness.

Outsole Composite Fabrication and Evaluation

Recycled PU foam was successfully integrated into fiber-reinforced TPU composites and processed into outsole test plugs using extrusion, molding, and additive manufacturing. Abrasion resistance, coefficient-of-friction measurements, and microscopy of abraded surfaces confirmed that the recycled-content containing composites largely maintained the durability and traction behavior seen in products produced with virgin TPU.

Conclusions

This project demonstrated a practical and scalable approach for converting mattress-derived PU foam into footwear-relevant materials. Both recycling pathways produced components that met performance expectations, and the resulting prototypes show strong potential for future development with industry partners. The work provides a foundation for continued scale-up, including higher recycled-content formulations and expanded real-world testing.