

Title: Mechanochemical Conversion of Flexible PU Foam into Functional Additives for Circularity

Discarded flexible polyurethane (PU) foam from mattresses presents both an environmental burden and a valuable feedstock for circular material innovation. This work introduces a novel mechanochemical strategy to convert waste flexible PU foam into surface-functionalized powders, which serve as high-performance additives for paints, lubricants, and polymer composites.

The process employs a proprietary grinder constructed with transition metal alloys, enabling precise control over particle size and surface chemistry through reactive grinding in the presence of functional gases. This approach facilitates the incorporation of polar functionalities, significantly enhancing compatibility with polymer matrices and enabling applications in rheology modification, insulation, and composite reinforcement.

The core innovation lies in the integration of mechanical grinding with in situ chemical surface modification—establishing a new pathway for circularity in PU foam recycling. We will present performance data from our grinder prototype and demonstrate the utility of the resulting functional powders in composite formulations, including their role in lightweighting polymeric systems.

This work directly supports the goals of the Mattress Recycling Council and the REMADE Institute by transforming hard-to-recycle mattress components into functional materials, , and lowering CO₂ emissions associated with conventional disposal and filler production.