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Advanced methods for the assessment of waste elastomer fillers

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In this study, the incorporation of waste elastomers, including ground tire rubber (GTR) and ethylene propylene diene monomer (EPDM) rubber into a waste high-density polyethylene (w-HDPE) matrix was investigated, with the focus on the impact of particle size and homogenization time on the mechanical, rheological, and structural properties of the resulting blends. The elastomeric fillers were fractionated into different particle sizes, and their interactions with the polymer matrix were analyzed using mechanical testing, oscillatory rheometry, scanning electron microscopy (SEM), calorimetry and inverse gas chromatography (iGC). It was found that the mechanical properties, particularly impact strength and elongation at break were significantly influenced by the particle size distribution and the homogenization time. Smaller elastomer particles enhanced the interface area, improving stress transfer and extending the linear viscoelastic (LVE) range, but excessive fractionation led to agglomeration, which diminished the mechanical properties. Rheological analysis revealed a relationship between the crossover frequency and the dispersion of elastomer particles, with the blend containing the smallest particle size exhibiting the highest molecular weight but poor homogeneity due to agglomeration. SEM images further confirmed the tendency for particle aggregation in blends with the smallest elastomer fractions. The results suggest that particle size distribution and sufficient homogenization time are critical for optimizing the dispersion of elastomer fillers in polymer matrices. Practical recommendations include the use of frequency sweep tests to assess whether fractionating elastomer fillers into specific size ranges would be beneficial for improving blend properties.