The road to tyre-to-tyre recycling: Tensile testing as a tool for determining the incorporation of rubber particles in a vulcanized matrix

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The amount of end-of-life tyres generated in the EU exceeded 3 million tons in 2021. 58 % of these are recycled, the remainder is thermally recovered. [1] However, recycling in this context mostly refers to open-loop recycling: Grinding of the tyre and usage of the resulting ground tyre rubber without further treatment, often as a substitute fuel for the cement industry. Devulcanization of rubber, the selective scission of S– S and C– S-bonds without breaking the main chain, is a necessary step for closing the loop, as it allows for reprocessing and revulcanization. Ideally, this can be realized without a decrease in the resulting material's mechanical properties. [2] With this in mind, the influence of untreated ground tyre rubber on the mechanical properties of vulcanized rubber mixtures commonly used in tyre formulations is investigated. Additionally, mixtures containing glass beads, an inert filling material, are investigated to gain conclusions about whether rubber particles are chemically integrated into the matrix. The aim of this work is to better understand the chemical incorporation of untreated rubber particles and devulcanizates in rubber virgin material.

Ground tire rubber with different particle sizes and glass beads of different diameters were mixed into two rubber mixtures, that are industrially used for retreading of tires. After vulcanization, tensile testing was performed according to ISO 37 and cyclic tests were conducted to calculate the crosslink density of the materials according to YEOH [3,4].

Tensile strength and elongation at break decrease to a greater extent when larger particles are contained in the material. Glass beads lead to similar effects as rubber particles, if the diameters are comparable. The decrease in crosslink density is also similar for materials with rubber particles and glass beads, which suggests that untreated rubber particles are not chemically bound into the rubber matrix through the vulcanization process.

Keywords: Rubber Recycling, Tensile Testing, Crosslink Density

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