

Recycling process for footwear cross-linked EVA waste using a mechanochemical batch method.

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Keywords

“Mechanochemical method”, “mixing rheometer”, “decrosslinked EVA”, “cell morphology”, “mechanical properties”.

Introduction:

Cross-linked ethylene vinyl acetate (EVA) products from footwear industry present multiple difficulties in terms of effective recycling methodology due to their chemical structure. For the most part, their recycling has been based on the incorporation of micronised waste into new formulations in low percentages (Paiva et al, 2021), so most of the waste is still destined for landfill at the end of its useful life.

In response to be able to recycle EVA in larger quantities, mechano-chemistry was studied as a promising solution for the activation of covalent bonds (Beyer, M.K. and Clausen-Xchaumann, H., 2005). Researchers Liu et al. (2013) performed mechano-chemical recycling of cross-linked EVA, obtaining promising results.

In the search for sustainable solutions to cross-linked EVA waste from footwear industry, INESCOP has carried out a research into the development of a mechanochemical recycling method to incorporate a higher percentage of recycled material in new formulations for footwear products.

Experimental:

In this study, a mechanochemical recycling method for cross-linked EVA waste has been developed using a mixing rheometer. The main principle of the method consists in the application of mechanical shear and temperature stresses, achieving the breaking of the cross-linked chains of the polymeric network. This method aims to obtain a recycled EVA product with similar properties to virgin EVA.

For its development, an experimental design has been carried out in which the key parameters of the process have been optimised: temperature, shearing speed and type of mixer. The recycled products were characterised using analytical techniques to evaluate the efficiency of the method and thus choose the optimum processing conditions. The techniques used were infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) and analysis of decrosslinked degree.

The recycled EVA product was used to formulate new footwear components of expanded EVA materials. These new materials were processed using typical industry foaming methodologies at laboratory scale and subsequently physically characterised to study the possible variation in mechanical properties and cell morphology compared to an EVA product without the addition of recycled material. The addition percentages of decrosslinked material in the expanded EVA formulations in replacement of virgin EVA were 10, 20, 50, 80 and 100 %.

Results:

The foaming percentage of the various formulation tests showed that, from 50 % of recycled material, both the expansion of the material and other properties starts to decrease significantly.

Likewise, in the SEM photographs, significant differences were only found from 80 % of incorporated recycled material, at which the cells of the material decrease in size and present an irregular size with respect to each other.

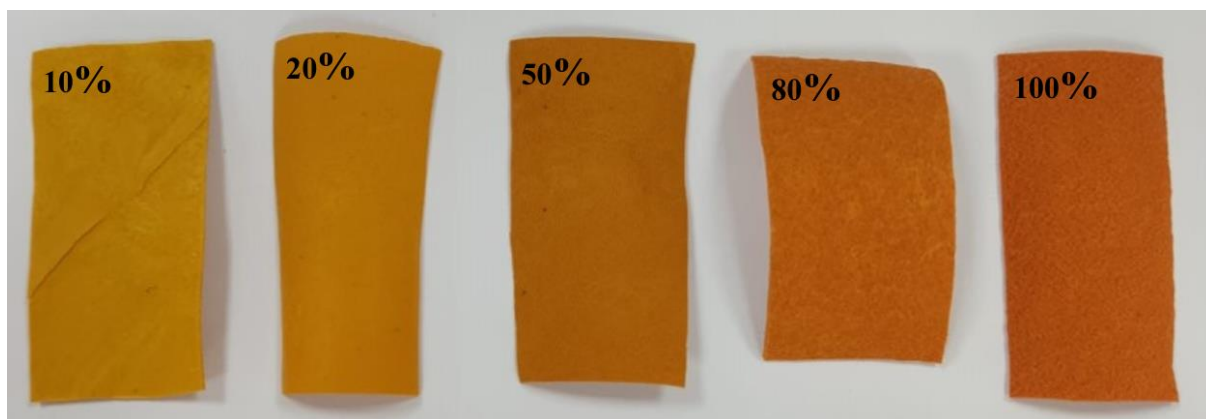


Figure 1: EVA foams with different percentages of decrosslinked EVA obtained from the mechanochemical recycling method developed.

Conclusion:

The development of a mechanochemical recycling method using a mixing rheometer has made it possible to recover cross-linked EVA waste which, until now, was only incorporated into the value chain through mechanical shredding.

The new recycled product has proved to be compatible in the formulation of new expanded EVA products through the study of its cell morphology and mechanical properties.

References

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