

course direction, and 39 to 43% in those cut stretched in the wale direction. As a result, post-deformation readability dropped to 0 % across all tested codes, regardless of size or orientation.

These findings underscore a critical constraint: the precision required for fine embroidered QR code elements limits their readability under repeated tensile deformation.

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UDC 687.3

EMILIJA MIELIAUSKAITE, DAIVA MIKUCIONIENE
 Faculty of Mechanical Engineering and Design, Kaunas
 University of technology, Studentu str. 56, Kaunas, Lithuania

FROM WASTE TO NEW DESIGN: CHALLENGES AND POSSIBILITIES

Purpose. *Raincoat development from recycled automobile tires and non-woven fabrics.*

Keywords: *Raincoat, end-of-life tires, circular economy, non-woven fabric.*

Objectives. Globally, approximately 1 billion end-of-life tires are generated annually, the majority of which end up in landfills. Automobile tires represent nearly 80% of global rubber waste due to the rapid growth of the automotive industry [1]. Within the framework of the “cradle-to-cradle” circular economy principle, this research proposes the design of a sustainable waterproof raincoat made from waste-derived materials. The idea has been expanded through entrepreneurial aspects in Eco-design Challenge [2]. This research idea suggests exploring hydrophobic fabric coating strategies, using devulcanized rubber granules for the film and non-woven fabrics as garment filing. This idea has several approaches for implementation, but to determine the most effective solution, prototypes from different coating films and non-woven fabric specimens need to be

tested. The desired outcome of this research is to create a raincoat, that would offer both thermal insulation and moisture protection, thereby extending its usability across multiple seasons and enhancing the overall product lifecycle. Implementation of this idea would also contribute to the solution of waste reduction and sustainability challenges.

Methodology. Theoretical approach and review of scientific literature.

Research results. To evaluate the feasibility of the proposed raincoat design, this research outlines how recycled rubber and nonwoven textiles can be combined to achieve the desired functionality and durability. Feedstock recycling of end-of-life tires is still not feasible, but a process, that can make rubber meltable and processable is called devulcanization [3]. To create a waterproof outer layer, a coating film with recycled rubber must be developed. Devulcanized rubber must be combined with latex, glycerine and ethylene vinyl acetate. The coating film is then ready to be sprayed onto the fabric. Since the waterproof membrane is not breathable, certain air vents must be included into the design. Nonwoven fabrics are made by disintegrating post-consumer textiles into individual fibres which are then carded and bonded together through needle-punching to form non-woven fabric panels [4]. These panels can then be cut according to size template and sewed with lining pieces. The principal development scheme is presented in Fig. 1.

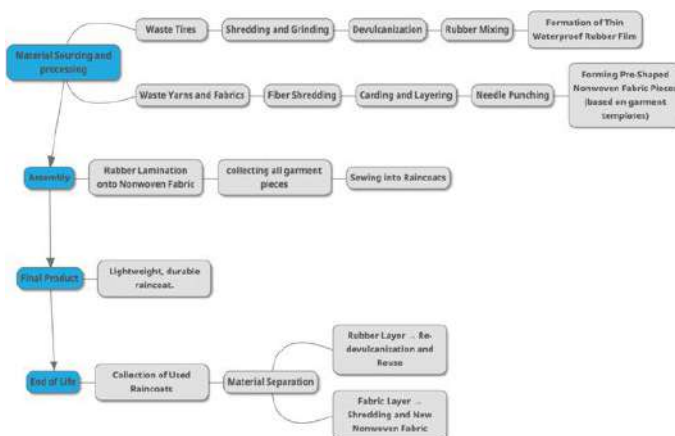


Fig. 1. Development scheme

The non-woven fabric insulates warmth; therefore, it is excellent as filling for the rain coat. However, several challenges may arise during the practical implementation of this idea. Firstly, a lot of research and experiments must be executed to create a coating film that would fit the right quality criteria to be not only waterproof, but elastic too.

Devulcanization itself is a complex and costly process, so it may be more practical to source devulcanized rubber from existing suppliers – although such companies are limited in number. Also, the production cost of this raincoat is relatively high, which may create difficulties in introducing it to the market and competing with mass-produced, low-cost alternatives.

Conclusion. Eco-design in textile and fashion industry focuses on finding innovative ways to reduce the environmental impact of the industry. This includes developing new sustainable materials, exploring new production methods, or turning waste into raw materials for new products. Using recycled rubber film for waterproofing and non-woven fabrics for coat filling offers the possibility of extending product usability across multiple seasons while simultaneously addressing waste reduction. Moreover, the creation and market success of such garments could stimulate further opportunities for tire recycling, as it would increase the demand for recycled rubber and encourage investment in innovative recycling technologies.

Acknowledgement. The presented research was co-funded by the Erasmus+ programme of the European Union under the project reference number 2023-1-ES01-KA220-HED-000157440. Views and opinions expressed are, however, those of the authors only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA).

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