A novel recycling approach for more sustainable sport equipment

Martino Colonna, Lorenzo Crosetta, Alessandro Nanni, Alessandro Speranzoni, Giuseppe La Fauci and Mariafederica Parisi
[1] DICAM-University of Bologna, Via Terracini 28, 40131 Bologna, Italy.

At the present moment, most of the sport equipment after use are directed to landfill due to the difficulty to efficiently separate and recycle their multi-material assembly [1]. Every year several kTons of materials (thermoplastic, metals etc), that could be reused, are discarded thus creating great environmental problems that affects the sustainability of sport equipment. For this reason, we have developed a series of new processes for the efficient and cost-effective recycle of sport equipment. In all processes the first step consists in an efficient system for the separation (mechanical or chemical) and purification of each single material. The separated materials are then optionally mixed with virgin materials and re-processed for the preparation of new sport equipment. The new equipment is then tested, according to standard procedures, in order to determine performances and safety characteristics. As an example, here we report the case of the complete recycling of end-of life ski-boots.

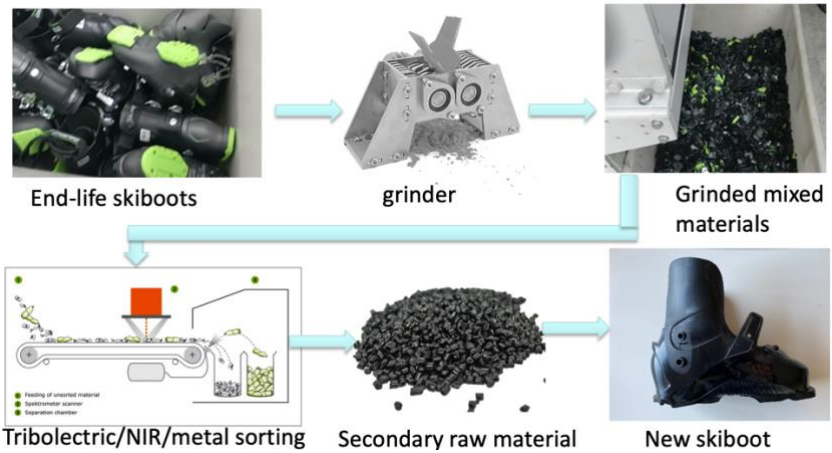

Fig. 1: scheme of the process for recycling of ski-boots

The grinded ski boots are separated by Triboelectric sorting, combined with UV-NIR and magnetic sorting, with an efficiency of 95%. The thermoplastic materials are then used to produce, by injection molding, the hard external shells. The rubber

Corresponding author email: martino.colonna@unibo.it

present in the soles has been devulcanized using a patented process, mixed with 70% of virgin rubber and then re-vulcanized to produce new soles. The foamed materials of the liners are re-agglomerated using the Rebonding technique, using 15% of polyurethane pre-polymers, and then used to produce new internal liners. The different parts have then been assembled and the ski boots tested in lab and real environment to assess their safety and performances using flexural test benches, impact tests and ISO5355 norm. A design for recycling step has also been performed in order to develop new ski boots that can be more efficiently recycled and with improved performances. This approach consists in a FEM analysis using Ansys Workbench 19/R2 software of the existing models that is then validated using a Digital Image Correlation (DIC) analysis using a GOM Aramis 3D system. The results are then topological optimized to obtain new ski boots with lower weight (and therefore less materials) and with improved performance and safety.

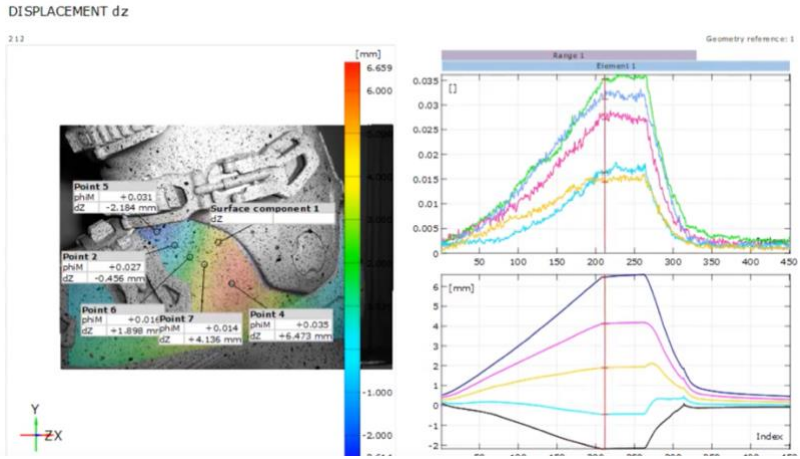

Figure 2: example of DIC analysis for the validation of the FEM model.

An LCA analysis (performed following the IPCC 2013 GWP 100 method) of the process has shown that every 1000 pair of ski boots recycled, 3268 Kg of materials are saved from landfilling, 12 tons of CO_2 are not emitted in the atmosphere and 308 GJ of energy is saved. The process is at moment in the scale-up phase with a 1000 pair/year production. A similar approach has also been implemented on other sport equipment such as helmets, body protectors, surf-boards, climbing shoes and outdoor shoes.

1. Subic A, A Mouritz, Troynikov O (2009) Sustainable design and environmental impact of materials in sports products. Sports Technol. 2, 67–79.

Corresponding author email: martino.colonna@unibo.it