

ADVANCED POLYMERIC MATERIALS FOR SPORT EQUIPMENT APPLICATIONS

RESEARCH GROUP: Martino Colonna; Maurizio Fiorini, Matteo Moncalero.

KEYWORDS: sport equipment, polymeric materials, dynamical-mechanical behavior, composites, 3D printing.

In the last years the polymer group of the DICAM has focused his attention towards the study of advanced polymeric materials for sport equipment, in particular for winter sports (e.g. ski boots, skis, ski helmets, gloves etc)

Our method is based on a scientific approach to choose and develop new materials with specific characteristics such as low weight, good visco-elastic properties, high impact resistance at low temperatures and gliding on snow. Thanks to our knowledge in the characterization and synthesis of polymeric materials we are able to use a new technique to evaluate and select appropriate materials for the different applications.

For example, through DMTA analysis we can evaluate the optimal parameters of the visco-elastic material's behavior. By analyzing the variation of the elastic modulus with temperature it is possible to evaluate the stiffening of the material in the different conditions of use. From the loss modulus (E'') it is possible to deduce the vibration's damping of the material and the speed of elastic return once the stress is finished. These parameters have a fundamental effect on the final performance of the sports equipment. The correct choice of material also helps in product design, providing higher performance and less weight. Moreover, the DMTA analysis allows to calculate the temperature at which the material softens.

Using those data we are able to modify the equipment's geometry through a thermoforming process that allows the customization of the product on the needs of the final user. We have performed studies using wireless sensors and thermographic cameras on the thermal comfort and moisture transport during the use of materials, equipment and technical sports clothing. In this field we have demonstrated the effect of compression and of foamed materials on thermal comfort.

Using our expertise in materials obtained from renewable sources, we can define the most appropriate materials, reducing the carbon footprint of the product.

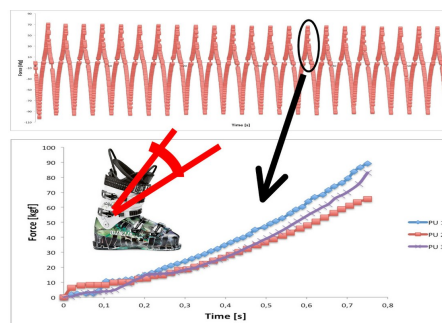


Fig. 1. Study of the flexural behaviour of ski boots (Figure by M. Colonna).

We are also working in the field of rapid prototyping of materials for sports using SLS and FDM 3D printing techniques.

We have won the Vibram factory award in 2015 with a project done with Nicola Pugno of university of Trento on new composite materials with improved grip on icy surfaces.


We have also extensively worked on materials for safety equipments (e.g. helmets and body protectors) winning together with Marker GMBH the ISPO gold Award in 2014.

MAIN PUBLICATIONS.

Colonna M., Nicotra M. Moncalero M. Materials, designs and standards used in ski-boots for alpine skiing. *Sports*, 1(4), 2014, pp. 78-113.

Nicotra, M., Moncalero, M., Colonna, M. Effect of the visco-elastic properties of thermoplastic polymers on the flexural and rebound behaviours of ski boots for alpine skiing. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 229(3), 2015, pp. 199-210.

Colonna, M., Moncalero, M., Nicotra, M., Pezzoli, A., Fabbri, E., Bortolan, L., Schena, F. Thermal Behaviour of Ski-boot Liners: Effect of Materials on Thermal Comfort in Real and Simulated Skiing Conditions. *Procedia Engineering*, 72, 2014, pp. 386-391. Dotti, F., Ferri, A., Moncalero, M., Colonna, M. Thermo-physiological comfort of soft-shell back protectors under controlled



environmental conditions. *Applied ergonomics*, 56, 2016, pp. 144-152.
Nicoira, M., Moncalero, M., Messori, M., Fabbri, E., Fiorini, M., & Colonna, M. Thermo-mechanical and impact properties of polymeric foams used for snow sports protective equipment. *Procedia engineering*, 72, 2014, pp. 678-683.

RESEARCH PROJECTS

We have research ongoing projects with several sporting equipment brands (Calzaturificio Dalbello; Marker gmbh; Level gloves; Montura)

LINKS AND CONTACTS

Martino.colonna@unibo.it