Abstract - New elastomeric materials obtained by biosourced monomers for high performance tyres

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Elastomeric materials (commonly called rubbers) play a fundamental role in human life, having myriad applications ranging from wiper blades to spacecraft seals, albeit most of the world's rubber ends up in tyre production. An elastomer can be defined as a polymeric material with the following typical characteristics: (1) the glass transition temperature should be lower than room temperature; (2) amorphous in unstrained conditions and (3) characterized by low Young modulus and high failure strain.

Generally, elastomers are obtained either from natural sources (known as 'Natural Rubber') or by synthesis. Modern industry and technology could not exist as they are today without synthetic rubber since natural rubber fails to meet the growing demand for worldwide rubber. The research described in this thesis focuses on the development of new synthetic elastomeric materials, obtained from renewable natural resources, for tyre production. Currently, the synthetic elastomers used in the tyre compounds (mainly polybutadiene and styrene-butadiene copolymers) are synthesized from monomers coming from fossil sources such as butadiene, isoprene and styrene. The need to abate the current environmental issues, such as global warming, and the massive amount of fossil-based plastic pollution that wind up in the oceans every year, urges a reduction in the usage of fossil-based materials, and their replacement with more sustainable alternatives. These issues have inspired many scientists to design and implement more sustainable approaches for polymer synthesis. The identification and assessment of new and renewable biobased monomers have become a major topic of interest en route to a circular economy. In this context, a natural, potentially alternative source of hydrocarbons is represented by the large family of terpenes, molecules characterized by the presence of one or more double bonds with a cyclic or acyclic unsaturated structure. They are formally oligomers of isoprene units produced by many plants, animals, and some insects. Despite their structural similarity with 1,3-alkadienes, their use as monomers for polymer synthesis has been scarcely investigated and gained attention only in recent times. The aim of this project was, therefore, the synthesis of polymeric materials starting from terpene monomers, testing their mechanical properties, and preparing the first compounds for high-performance tires, in order to partially replace the rubbers obtained from fossil sources. These researches were conducted in collaboration with Pirelli S.p.a. (Milan, Italy), in whose laboratories the mechanical properties of compound formulations, obtained from terpene-based elastomers synthesized, have been studied.