STRENGTH, DAMAGE AND FRACTURE OF HIGHLY DEFORMABLE POLYMERIC MATERIALS

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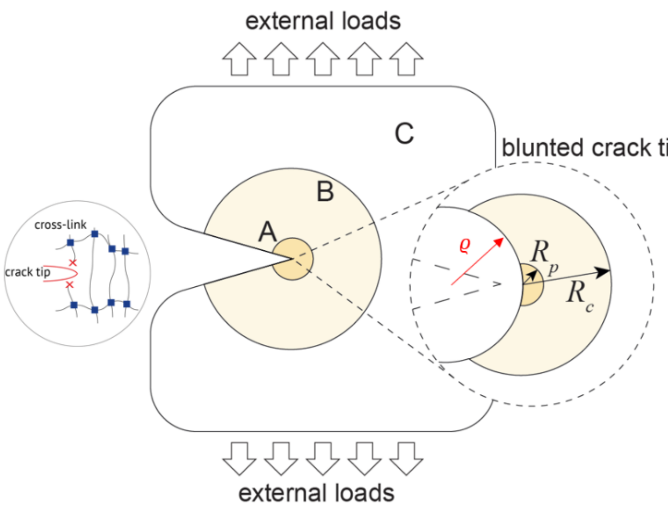
Mechanical response of highly deformable materials, especially polymers, elastomers, foams, gels, biomimicking phantom tissues, is far from being fully understood. In fact, their response under mechanical (stress) or other physical stimuli (temperature, interaction with fluids, etc.) requires to account for a broad range of effects such as large strain, entropic deformation energy, strain rate-related phenomena, hysteresis loops (Mullins effect), coupling with other physics (diffusion of fluids, self-diffusion of material's molecules, heat diffusion, etc.), all of them make modelling this class of materials still an open issue.

Understanding how strength, fracture toughness and all the main material's mechanical parameters are related to its microstructure and to the production process (nowadays often performed by using high-precision modern additive manufacturing technologies) is a crucial task for truly engineered synthesis and building procedures.



Further, the development of physics-based continuum models suitable to be implemented in computational codes, is required for the design of new structures and devices to be used in a broad range of advanced applications, ranging from civil engineering (sensors, deployable structures), to mechanics and biomechanics (soft robots, tunable actuators, wearable devices, robotic surgery).

The aim of the present research topic is to comprehensively study the microstructure-mechanical response relationship of highly deformable polymeric materials, in order to fully understand the underlying damage and failure mechanisms and to define new testing procedures and measurement strategies suitable to properly characterize their mechanical properties. Fracture-related failure mechanisms are studied in the context of remotely applied loading as well as of 'local' actions (e.g. see cutting and puncturing mechanisms).

Solving the above-listed issues will provide an incredibly wide design space, not offered by other traditional materials such as metals and ceramics, enabling the production of architectured materials with a controllable and tunable response (materials by design).

Relevant papers

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- Spagnoli, A., Brighenti, R., Cosma, M.P., Terzano, M. Fracture in soft elastic materials: Continuum description, molecular aspects and applications (2021) Advances in Applied Mechanics.
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