Polymeric foams 3D numerical mechanical modelling

Abstract:

One of the main open issues in the field of polymeric foam materials is the lack of a relationship between the foam geometrical characteristics and its constituent material properties, on one side, and the macroscopic mechanical behavior. This link is an essential ingredient for the development of a predictive numerical model able to fully describe the mechanical behavior of polymeric foams under different loading conditions, which is the ultimate goal of the present work.
In order to build up a systematic and methodological approach to this problem, polymeric structural closed cell foams having different nominal densities (ranging from 60 to 320 kg/m^3) were considered. The internal foam structure was investigated throughout micro-Computed Tomography; the acquired stack of images were processed with a home-made algorithm in which Mean Intercept Length method was implemented to compute material volume distribution and the degree of structural anisotropy. The algorithm also allowed the reconstruction of the real geometry using a voxel-based scheme, to perform Finite Element Analysis. With the aim of reducing geometric discontinuities, inherent in the reconstructed voxel mesh, Taubin's smoothing algorithm was employed to obtain more accurate results. Numerical simulations mimicking experimental quasi-static uniaxial compression test were performed to obtain nominal stress vs. strain curves. To this purpose, suitable mechanical properties were identified for the (equivalent solid) constituent material: the resulting constitutive law highlights the contribution of the material to the macroscopic foam properties. Relevant mechanical parameters such as elastic moduli, buckling strain and plateau stress were then evaluated and related to geometrical features of the real foam.