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Three dimensional quantification of anisotropic void evolution in deformed semi-crystalline Polyamide 6

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Abstract

The evolution of voids has been used as an efficient indicator of the volume changes occuring during deformation for polymers which undergo high levels of plasticity. This has to be taken into account in determining the constitutive models for these polymers. Void growth during uniaxial stretching of a semi-crystalline polyamide 6 has been studied using 3D image analysis of tomography data. Tests on axi-symmetrical notched round bars have been stopped at : (i) the maximum net stress ; (ii) the end of the stress softening stage ; (iii) the onset of the final failure. Local synchrotron tomography has been performed so as to observe voids in a predetermined volume of interest around the minimum net section. The shape of the voids was found to be cylindrical. Mathematical morphology analysis was used to identify 3D voids, allowing the void diameter and height histograms to be obtained. An anisotropic shape factor parameter was defined as the ratio between the void diameter and the void height. This shape factor was found to evolve with the degree of deformation. The principal strain components of the voids were calculated and plotted, showing anisotropy and a heterogeneous distribution. The irreversible void growth noted as plastic dilation was also found to be heterogeneous in the deformed net section.

Keywords: A. Voids and inclusions, B. Finite strain, B. Polymeric material, B. Porous material, B. Finite elements

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