THE EFFECT OF MICROSCOPIC HETEROGENEITY ON MICRO- TO MACROSCOPIC DEFORMATION BEHAVIOR OF AMOPHOUS POLYMER

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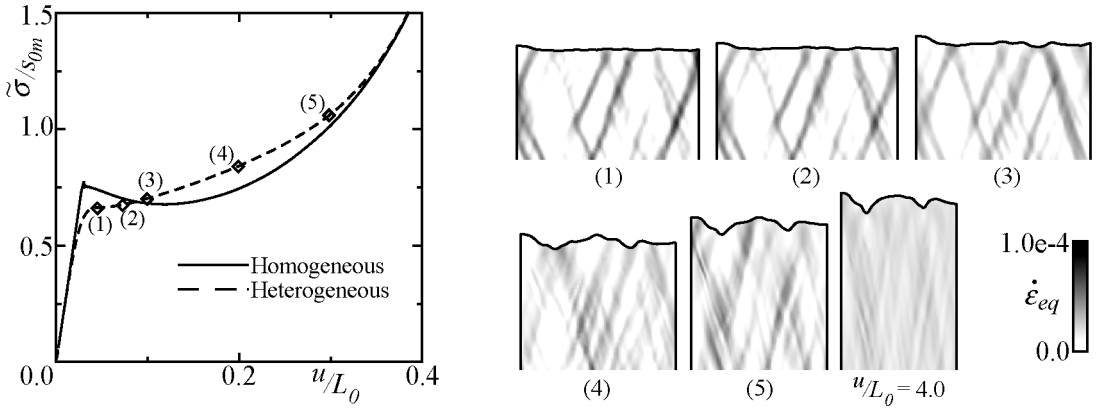
An amorphous polymer deforms due to onset and growth of microscopic shear bands. The characteristic deformation behavior is deeply related to the highly heterogeneous microstructure of an amorphous polymer. An experimental investigation by Atomic Force Microscope (AFM) observation [1] and large scale Molecular Dynamics (MD) simulation [2] suggested the heterogeneous distribution of the molecular chains. In this study, the characteristic deformation behavior of an amorphous polymer is numerically specified by employing a nonaffine molecular chain network model [3] with a heterogeneous chain distribution which was replaced by the heterogeneous initial shear strength and finite element simulation.

A series of computational simulations of the deformation behavior clarified the characteristic features of the micro- to macroscopic deformation behavior. For the case of macroscopically uniform deformation, the heterogeneous distribution of the initial shear strength causes the onset of micro shear bands connecting the weak points, appear at almost 45 degree with respect to the principal stretch direction, which causes the nonlinear behavior before onset of macroscopic yielding and lowers the corresponding macroscopic yielding stress. Figure 1 indicates the heterogeneous deformation of the surface of the plane strain block under compression. The undulation caused by the nonuniform deformation beneath the surface manifests different features depending on the stages of deformation. The wavelength of the undulation changes as the deformation proceeds which is corresponding to that reported based on AFM observation [1].



(a) Macroscopic Nominal Stress vs. Strain (b) Evolution of Surface Undulation

Fig. 1 Simulation Results of Undulation of Surface of Plane Strain Block under Compression

References

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