Local heating and viscosity drop during shear band evolutionin bulk metallic glasses under quasistatic loading

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Based on the facts that the thickness of a shear band in bulk metallic glasses _BMGs_ is a few tens of nanometers, the shear displacement across the band is few micrometers, and the time for their formation is in submicrosecond duration, the local strain rates within the shear band can be as high as 109 / s. To capture such dynamic effects, a thermo-micromechanical model based on momentum diffusion mechanism, free-volume theory, and heat diffusion analysis is proposed. The model has been shown to capture the characteristic rate effects, i.e., significant local temperature rise and a dramatic drop in viscosity during shear band evolution in BMGs. The model also takes into account the effects of normal stress component on the deformation behavior of BMGs. While the predicted maximum temperature rise under quasistatic deformation in the absence of normal component of stress is low _300 K_, significant temperature rise well above 1000 K accompanied by a sudden drop in viscosity has been predicted under dynamic loads at high normal pressures. It is also predicted that temperature rise and viscosity drop are negligible during the early phase of shear band formation but increase significantly towards the final phase of shear band evolution and cause subsequent fracture, as has been theorized by many researchers in the literature.