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Symmetric Notches Cause Strengthening in Brittle Metallic glasses

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Abstract: For all engineering materials, the flaws are introduced inevitably from fabrication, mechanical damage, and corrosion. These stress raisers always induce catastrophic failures and it is therefore of great importance to understand the effect of flaws on the mechanical properties of engineering materials. The effect of flaws on metallic glasses (MGs) is a debatable topic because many relevant works have reported notch strengthening, notch weakening and notch insensitivity for brittle MGs. The significant notch strengthening of MGs was attributed to the transition of failure mechanism, from catastrophic shear banding to ductile fracture. Here we investigate systematically the influence of notch geometry on mechanical behaviors of symmetrically notched MGs by molecular dynamics, including the notch depth, notch height and notch sharpness. Our work observes notch strengthening obviously in brittle MGs with a brittle failure through shear banding. This noteworthy notch strengthening is a consequence of the constrained growth of the plastic zone. A transition from shear banding to homogeneous deformation within the un-notched ligament can be viewed by increasing the notch depth when the un-notched ligament width is under the threshold value, and also a stronger notch strengthening. Besides, the sharper notch enhances the fracture strength more apparently. Another important finding is the determined demand of notch configuration for observed notch strengthening. It is found that the notch strengthening behavior would be degraded by single-edge notch or asymmetric double-edge notches. Current results provide important insights into the deformation and failure modes of notched MGs, which may guide the design and engineers of MGs.

Keywords: Metallic glasses; symmetric notches; notch strengthening; molecular dynamics simulation

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