

Size dependence of flow stress in amorphous nanowires at temperatures near glass transition

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The unique microstructure and properties of amorphous materials make them attractive candidates for applications such as precision components in micro-electro-mechanical systems. There is consequently great interest in fabricating sub-micron and nanoscale components of amorphous materials. This will require a thorough understanding of their properties.

To this end, we have computed the flow stress of amorphous metallic nanowires that are deformed at temperatures near the glass transition. Our molecular dynamic simulations (Fig 1) predict a strong size dependence of flow stress, and predict the existence of a critical wire radius that minimizes the flow stress (Fig 2). The size dependence is caused by a transition in deformation mechanism from viscous shearing in large wires, to a mechanism involving nucleation and diffusion of free volume in small wires (Fig 3).

One implication of these results is that a critical size exists that will optimize the formability of a nano-scale metallic glass component.

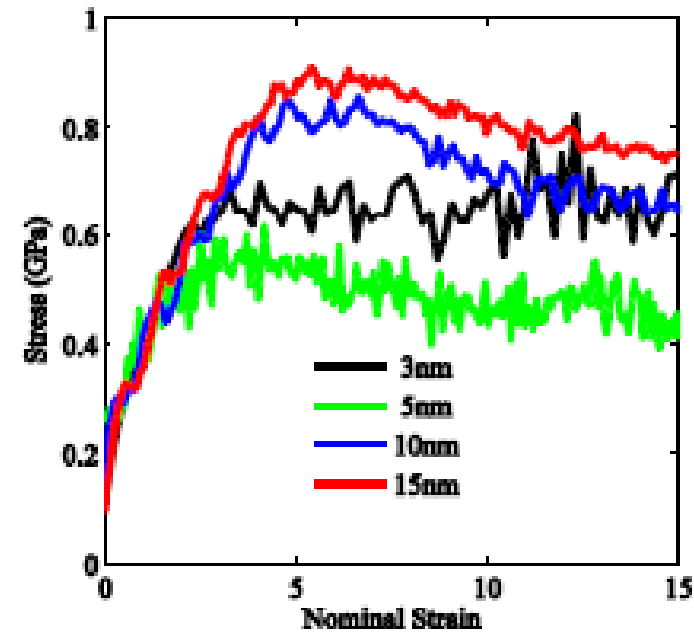
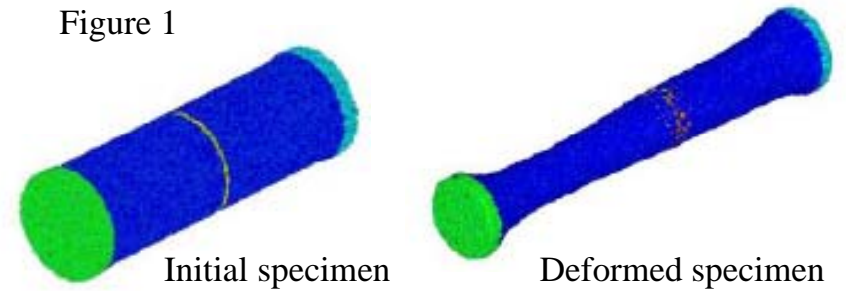


Figure 2: flow curves for amorphous nanowires of various radius

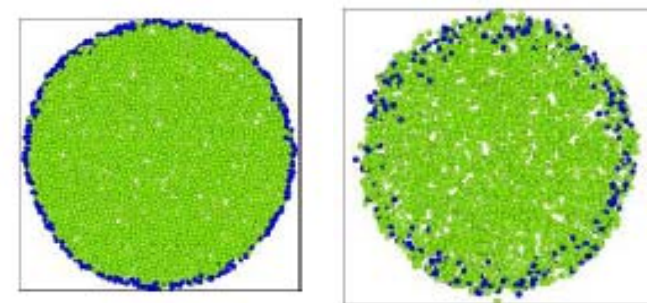


Figure 3: wire cross sections before and after deformation. Note free volume nucleation and diffusion