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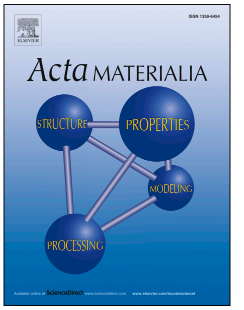

A quantitative connection between shear band mediated plasticity and fracture initiation toughness of metallic glasses

R.L. Narayan, Devaraj Raut, U. Ramamurty

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A quantitative connection between shear band mediated plasticity and fracture initiation toughness of metallic glasses

R.L. Narayan, Devaraj Raut, and U. Ramamurty*

Department of Materials Engineering, Indian Institute of Science, Bangalore 560012, India.

Abstract

While it is well recognized, albeit qualitatively, that shear band mediated plasticity ahead of crack or notch tips is the *raison d'être* for the high fracture toughness of 'ductile' bulk metallic glasses (BMGs), quantitative connection between those two material properties is yet to be established. In an attempt to study this, we examine if mode I fracture initiation toughness, K_{Ic}, of a number of BMGs can be related to the shear band number, N_i, which is a discretized measure of plasticity in MGs, around spherical indentation impressions that are made to a fracture mechanism based predetermined indentation strain. Results show that K_{Ic} scales with $(N_i)^{3/2}$. Then, the relation between the shear band density in the notch tip plastic zone, N_n, and K_{Ic} is examined, which shows that a power law: $K_{Ic} \propto (N_n)^{1/2}$, captures the data reported in literature for a number of BMGs. This result confirms that it is indeed the notch tip plasticity that determines K_{Ic} of BMGs. The power law exponent of 0.5 is rationalized by recourse to elasto-plastic fracture mechanics. Possible connections between N_i and N_n, ways of enhancing the latter so as to increase K_{Ic}, and the central role played by the relative density of MGs in determining both elastic, plastic, and fracture responses are discussed.

Keywords: Bulk metallic glass; Mechanical behavior; Fracture toughness; Plastic deformation; Shear bands.

*Author for correspondence; ramu@iisc.ac.in