INDIAN INSTITUTE OF SCIENCE
BANGALORE

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INSTITUTE COLLOQUIUM

by

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on

Fracture Behaviour of Bulk Metallic Glasses

Date : Tuesday, 11th October 2011
Venue : Faculty Hall, Main Building
Time : 4-00 p.m

Professor P. Balaram, Director
will preside

Tea: 5-15 p.m Reception Hall

Abstract

Bulk Metallic Glasses (BMGs) are a class of newly emerging materials with many attractive properties like high strength, stiffness and good corrosion resistance. They have many potential engineering applications like in biomedical devices, sporting goods and defense equipment. However, BMGs may exhibit poor fracture resistance which can impede their usage in structural components. A detailed understanding of the physical mechanisms that govern fracture in these materials remains elusive. This lecture will examine the fracture behaviour of BMGs through a combination of experiments, finite element modeling and atomistic simulations.

Fracture experiments were recently conducted using Vit-1 (a Zr-based BMG) specimens corresponding to as-cast and various annealed conditions to induce different structural states. The results show that ductile fracture occurs by crack growth inside a dominant shear band in the as-cast specimens. The fracture mechanism, which involves Taylor's fluid meniscus instability operating inside the shear band, was studied through detailed SEM fractography. Finite element simulations were also performed using an elastic-plastic constitutive model based on the Mohr-Coulomb yield condition. The numerically predicted shear band patterns near the notch tip compare well with the experimental observations. By contrast, in the fully annealed Vit-1 specimens, brittle fracture occurs and the fracture surface exhibits several interesting features.

Recent atomistic simulations broadly corroborate with the above experimental findings. These simulations show shear band mediated plastic flow and intense crack blunting in a ductile BMG, whereas fracture by a cavitation mechanism is noticed for a brittle BMG. The cavitation behavior is rationalized by noting that nano-scale fluctuations in atomic density are observed in the brittle BMG which give rise to weak regions with low local yield strength. Finite element modeling results are presented to support this hypothesis.