Tata Institute of Fundamental Research
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Students' Annual Seminar

Necking or cavitation in amorphous solids: A geometric phenomenon

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Amorphous solids are ubiquitous in nature and mechanical properties of these materials are of immediate importance for their industrial applications. The materials, which break catastrophically with small deformation, are called brittle materials and those, which can sustain longer deformation before failure, are termed as ductile materials. There are many parameters, which determine whether a material will break under external loading in brittle or ductile manner. Two such parameters, which are of practical importance, are the size and geometric shape of the material. It is recently found that mechanical properties of a material at nanoscale can be completely different from their bulk counterparts. In general it is well known that bulk brittle and quasi-ductile materials fail via formation and subsequent merging of cavities but a proper microscopic understanding of cavity formation in these materials are still lacking. In this work we study mechanical response of a model glass forming liquid as a function of varying geometric aspect ratio and sample size. Our results suggest that for a given temperature and straining condition, the sample shows cavitation only when the aspect ratio reaches a critical value and below this aspect ratio the sample breaks by forming neck, which are reminiscent of ductile material. The critical aspect ratio seems to also depend on the straining rate for a given temperature. We verified our results by two different approaches- one is by calculating maximum ductility and another by measuring the curvature of the sample. We feel that this observed transition from ductile like failure to cavity dominated brittle like failure, as a function of aspect ratio will be very useful in future to understand the role played by formation of cavities in deformation and subsequent failure of these materials.

Friday, Apr 26th 2019

2:00 PM (Tea/Coffee at 1:30 PM)

Seminar Hall, TIFR-H