3.5 Fracture

Fracture: separation of a body into pieces due to stress at temperatures below the melting point.

Steps in fracture:

- crack formation
- crack propagation

Depending on the ability of material to undergo plastic deformation before the fracture. Two fracture modes can be defined - **ductile or brittle**

- **Ductile fracture** - most metals (not too cold):
  - Extensive plastic deformation ahead of crack
  - Crack is "stable": resists further extension unless applied stress is increased

- **Brittle fracture** - ceramics, ice, cold metals:
  - Relatively little plastic deformation

Crack is "unstable": propagates rapidly withoutincrease in applied stress

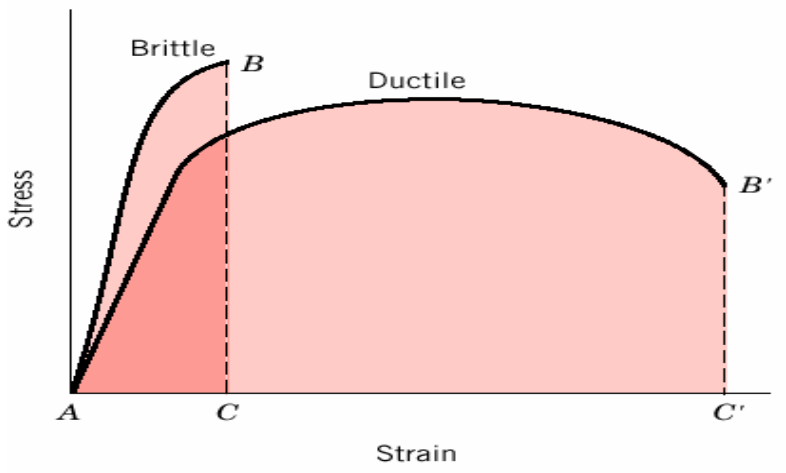
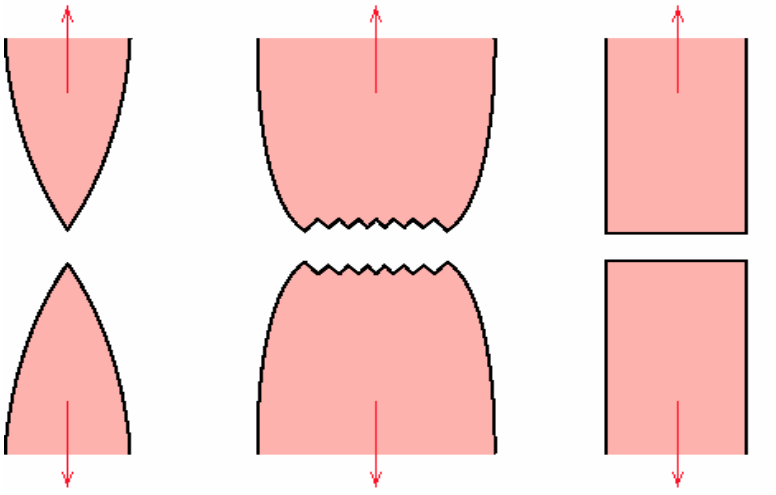


Fig 3.5.1 stress-strain curve

- **Ductile materials** - extensive plastic deformation and energy absorption ("toughness") before fracture.

- **Brittle materials** - little plastic deformation and low energy absorption before fracture.



A **B** **C**

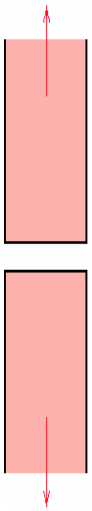
A. **Very ductile**, soft metals (e.g. Pb, Au) at room temperature, other metals, polymers, glasses at high temperature.

B. **Moderately ductile fracture**, typical for ductile metals

C. **Brittle fracture,** cold metals, ceramics.

Brittle Fracture (Limited Dislocation Mobility)

- No appreciable plastic deformation
- Crack propagation is very fast
- Crack propagates nearly perpendicular to the direction of the applied stress
- Crack often propagates by cleavage - breaking of atomic bonds along specific crystallographic planes (cleavage planes).



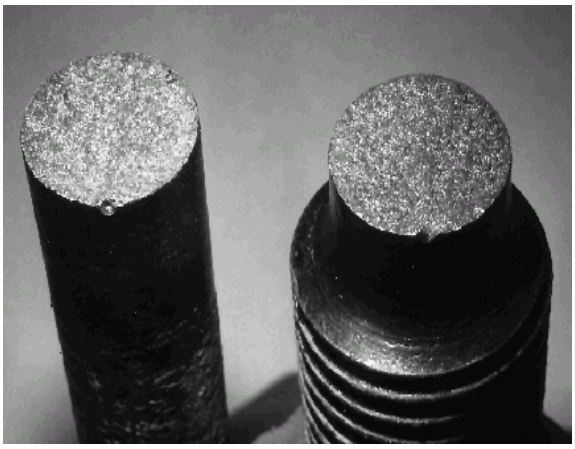


Fig 3.5. 2 brittle fracture in a mild steel

Brittle Fracture-Types

A. Trans granular fracture: Fracture cracks pass throughgrains. Fracture surface have faceted texture because of different orientation of cleavage planes in grains.

B. Inter granular fracture: Fracture crack propagation is along grain boundaries (grain boundaries are weakened by impurities segregation etc.)