Mechanical properties of solids

- Solid State Physics: An Introduction, by Philip Hofmann (2nd edition 2015, **ISBN-10:** 3527412824, **ISBN-13:** 978-3527412822, Wiley-VCH Berlin.
- (Advanced Texts in Physics) Harald Ibach, Hans Lüth (auth.) - Solid-State Physics_ An Introduction to Principles of Materials Science-Springer-Verlag Berlin Heidelberg (2009)-

Mechanical properties of solids: contents

- basic definitions: stress and strain
- elastic and plastic deformation, fracture
- macroscopic picture for elastic deformation: Young's modulus, Hooke's law, Poisson's ratio, shear stress, modulus of rigidity, bulk modulus.
- elastic deformation on the microscopic scale, forces between atoms.
- atomic explanation of shear stress / yielding to shear stress, dislocations and their movement
- plastic deformation, easy glide, work hardening, fracture
- brittle fracture, brittle-ductile transition

Basic definitions

stress: force on an object per area perpendicular to force

$$\sigma = \frac{F}{A}$$

unit: Pa

- Fig 3.1 Solid State Physics: An Introduction, by Philip Hofmann Wiley-VCH Berlin.

strain: length change relative to absolute length

$$\epsilon = \frac{\Delta l}{l}$$

unit: dimensionless
technical: m/m

Basic definitions

tensile stress

compressive stress

- Fig 3.1 Solid State Physics: An Introduction, by Philip Hofmann Wiley-VCH Berlin.

Elastic and plastic deformation, fracture

what happens when the tensile stress is increased?

1. elastic deformation (reversible)
2. plastic deformation (irreversible)
3. fracture

- Fig 3.1 Solid State Physics: An Introduction, by Philip Hofmann Wiley-VCH Berlin.

Materials which show plastic deformation are called ductile.

Materials which show no plastic deformation are called brittle.

stress/strain curve for a ductile metal

$$\sigma = \frac{F}{A}$$

$$\epsilon = \frac{\Delta l}{l}$$

- Fig 3.2 Solid State Physics: An Introduction, by Philip Hofmann Wiley-VCH Berlin.

Macroscopic picture: elastic deformation

the linear region

- Fig 3.1 Solid State Physics: An Introduction, by Philip Hofmann Wiley-VCH Berlin.

- Fig 3.2 Solid State Physics: An Introduction, by Philip Hofmann Wiley-VCH Berlin.

behaviour is linear and reversible for a strain of up to 0.01 or so

Young's modulus

stress: force on an object per area

$$\sigma = \frac{F}{A}$$

strain: length change relative to absolute length

$$\epsilon = \frac{\Delta l}{l}$$

Young's modulus

$$Y = \frac{\sigma}{\epsilon} = \frac{F}{A}\frac{l}{\Delta l}$$

unit: Pa

Young's modulus and Hooke's law

Young's modulus

$$Y = \frac{\sigma}{\epsilon} = \frac{F}{A}\frac{l}{\Delta l}$$

Hooke's law

$$F = \frac{YA}{l}\Delta l$$

stress $\sigma = \frac{F}{A}$

strain $\epsilon = \frac{\Delta l}{l}$

Young's modulus