

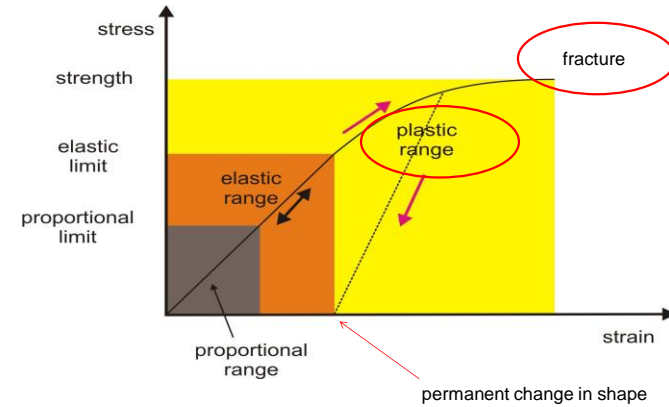


Physical basis of dental material science 8.

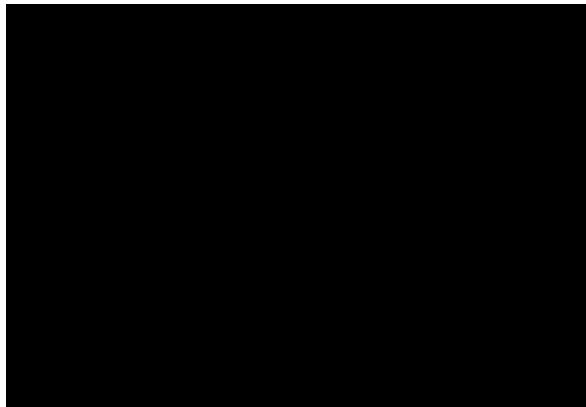
Mechanical properties 2.

1

Stress-strain diagram

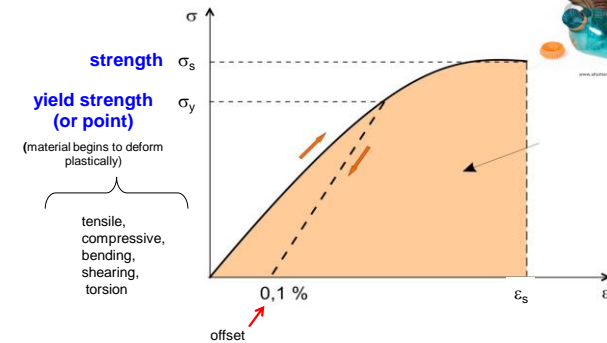


2



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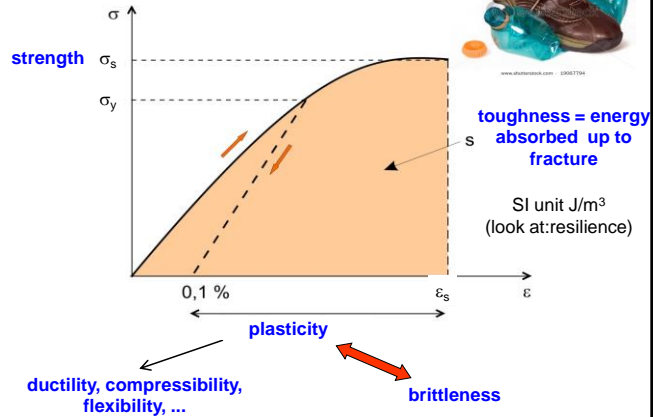
Plastic deformation: deformation of a material, non-reversible changes of shape



offset yield point: if there is no well-defined yield point. (offset may be: 0.1, or 0.2% ...)

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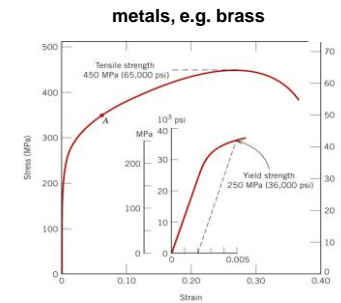
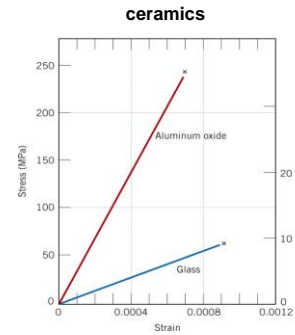
Plastic deformation: deformation of a material, non-reversible changes of shape



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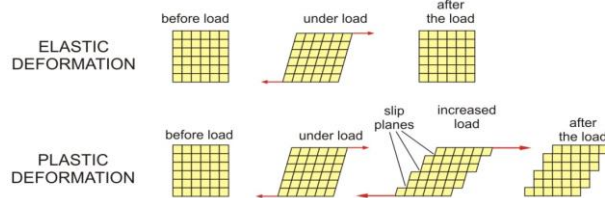
brittle material

ductile material



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Mechanism of the deformation in crystals

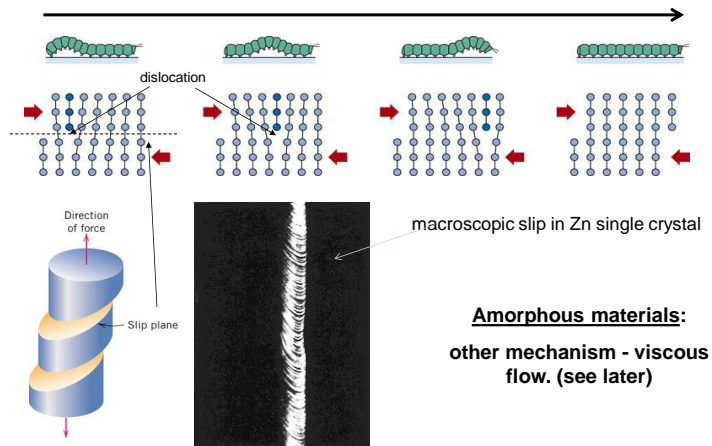


Plastic deformation: planes are shifted due to the reformed bonds.

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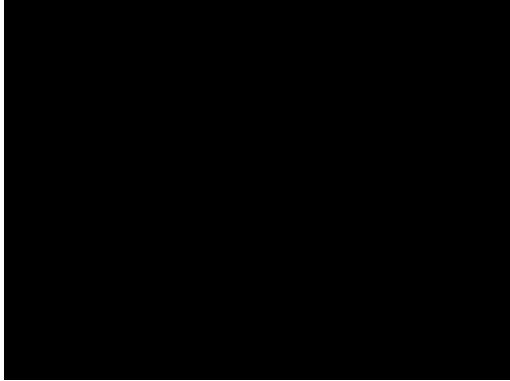
Crystals (slip):

Slip: plastic deformation due to the dislocation motion.

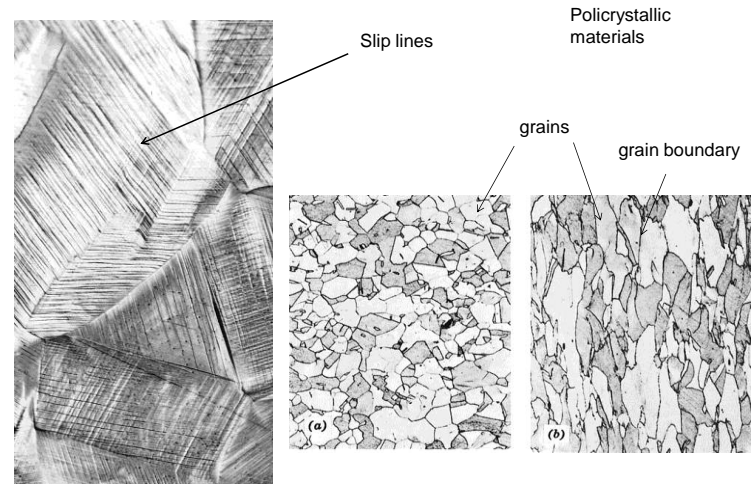


Amorphous materials:
other mechanism - viscous flow. (see later)

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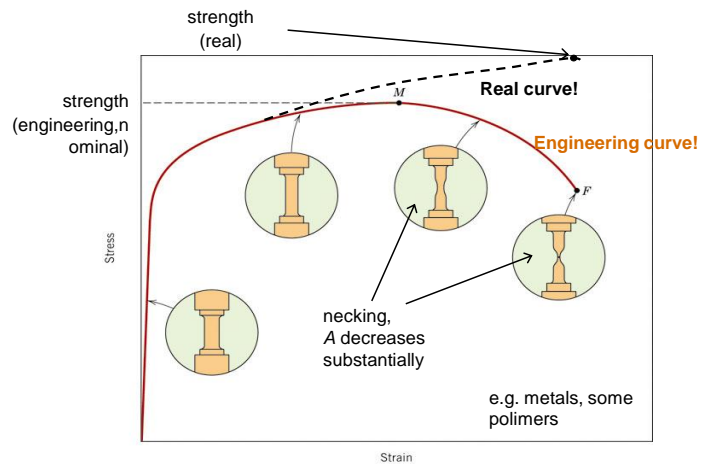


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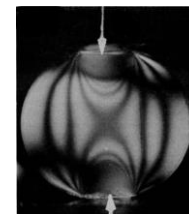
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Engineering system vs. „real system“



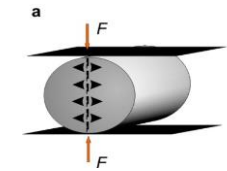
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Strength measurements



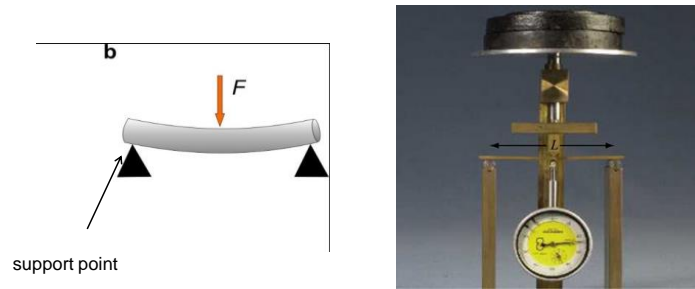
tension

Diapetral compressive test



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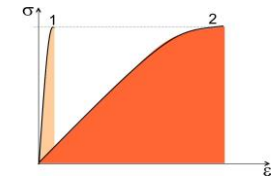
3-point bending test



Tensile and compressive strength of some dental materials:

| material | σ_s , tensile (MPa) | σ_s , comp (MPa) |
|--------------------------------|----------------------------|-------------------------|
| Enamel | ≈ 10 | ≈ 400 |
| dentine | ≈ 110 | ≈ 300 |
| Amalgam | 30-55 | 200-450 |
| gold | 108 | |
| Gold alloys | 300-900 | |
| Pd-Ag alloys | 400-700 | |
| Co-Cr alloys | 600-800 | |
| Ni-Cr alloys | 400-900 | |
| Glass | ≈ 70 | ≈ 700 |
| Ceramics | 5-400 | 20-5000 |
| Porcelain | ≈ 25 | ≈ 300 |
| PMMA (polimethyl methacrylate) | ≈ 50 | ≈ 80 |

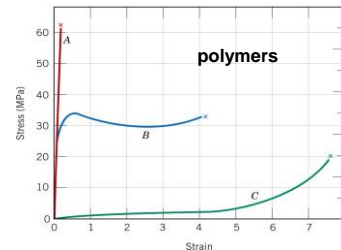
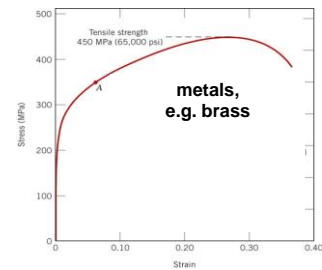
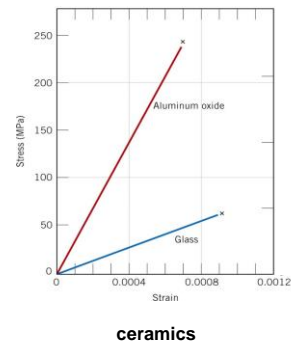
Strength \leftrightarrow toughness:



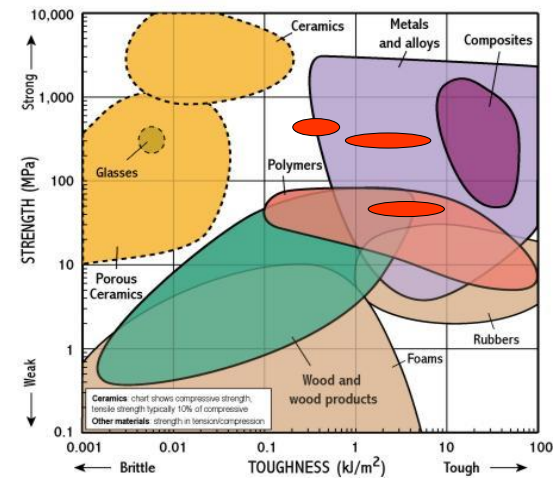
Plastic material more tough if the strength are same.

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examples:

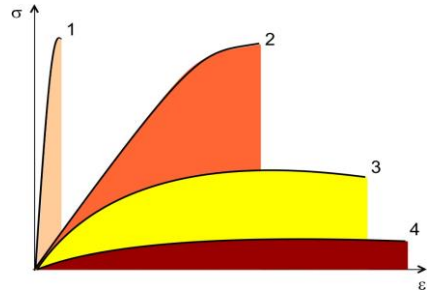


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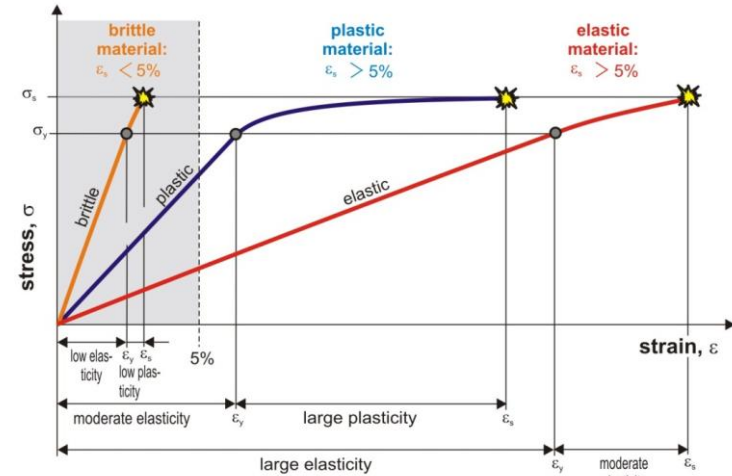
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Summary of different properties

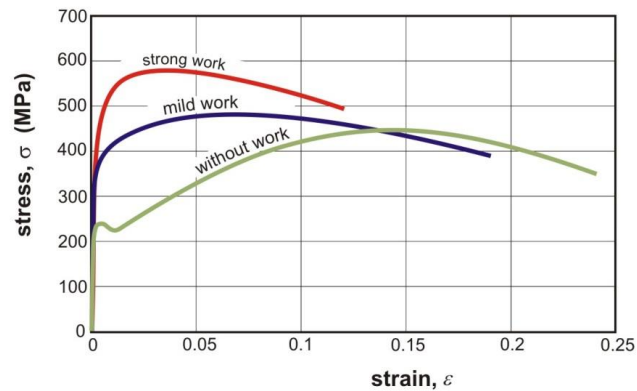


- 1) rigid (brittle), strength (strong), small toughness, brittle
- 2) flexible, stiff (strong), tough
- 3) ductile, medium strength, tough
- 4) ductile, small strength(weak), small toughness

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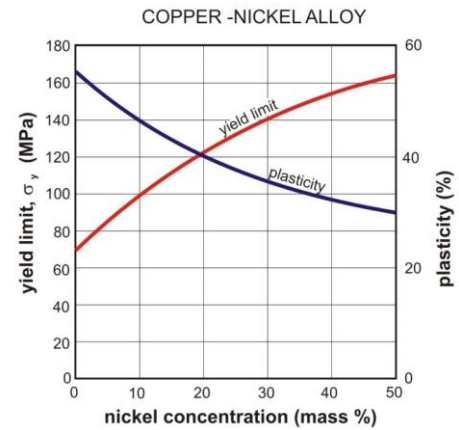


Cold-work



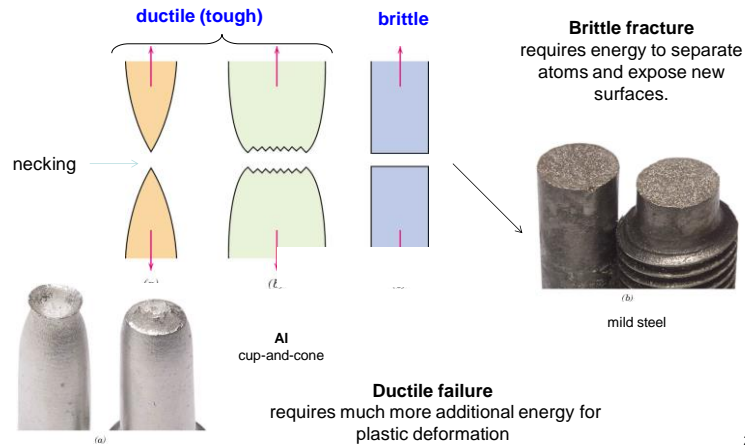
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Alloying



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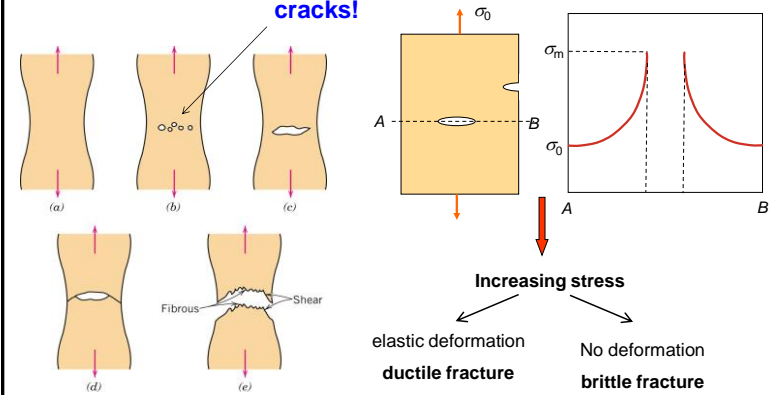
Fracture



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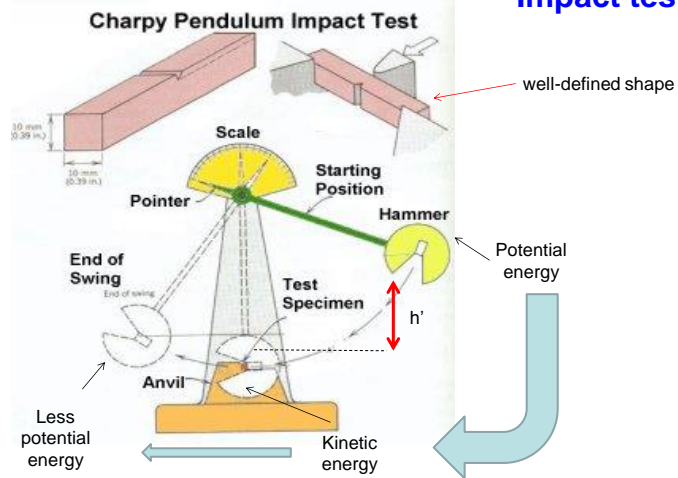
ductile (tough)

cracks!



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Impact test



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Quantities

$$E_{\text{pot}} = mgh'$$

Impact energy:
the gravitational energy loss of the hammer (J)

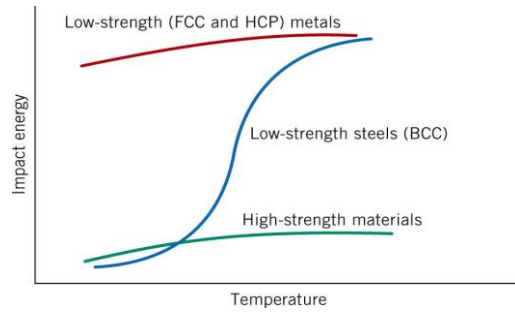
Specific impact energy:
impact energy/cross-section of the specimen (J/m^2)



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ductile – brittle transition

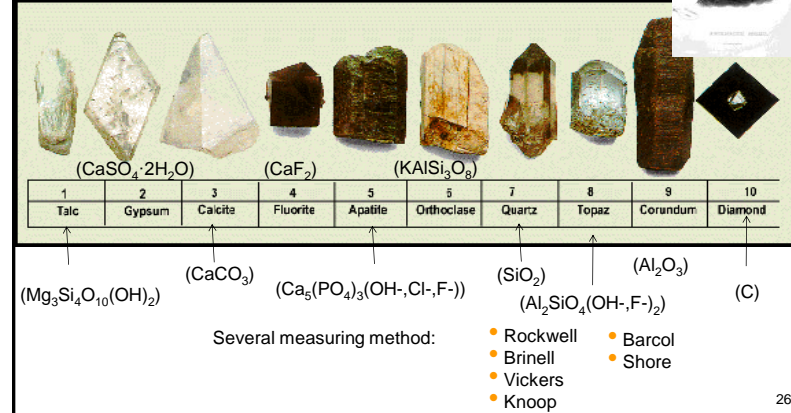
BCC: body-centered cubic
FCC: face-centered cubic
HCP: hexagonal closed packed



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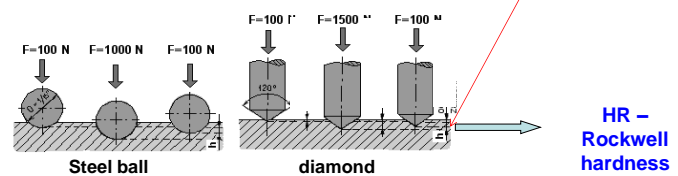
Hardness

Mohs scale:



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Rockwell:

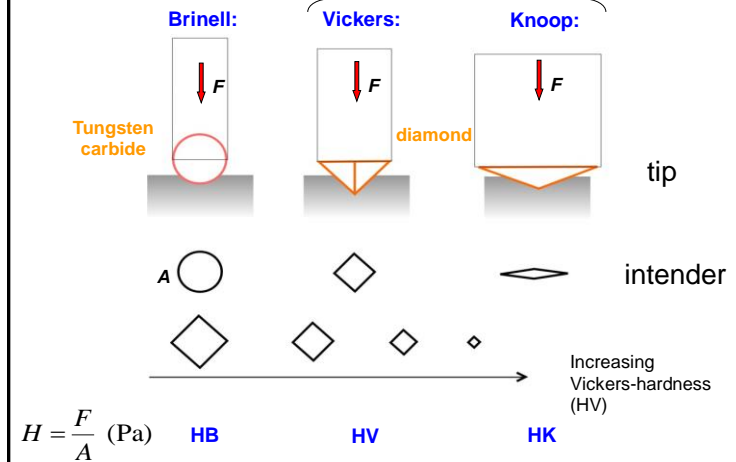


Rockwell C Test 4940 Sy=1.93 ksi u=-.2
h line= 0.000025+0.00
da f = 0.100000C+0.01



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Microindentation hardness tests

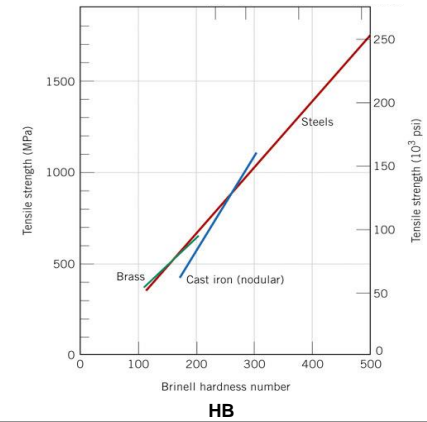


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Relationship to other quantites:



hardness
↕
Elastic limit

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Hardness of some dental materials:

| material | HV (MPa) | HK (MPa) |
|--------------|-----------|-----------|
| Enamel | ≈ 3400 | 3400-4000 |
| Dentin | ≈ 600 | ≈ 700 |
| Amalgam | ≈ 1000 | |
| Gold | | 60-70 |
| gold alloys | 600-250 | ≈ 2000 |
| Pd-Ag alloys | 1400-1900 | |
| Co-Cr alloys | ≈ 4000 | 3000-4500 |
| Ni-Cr alloys | 3000-4000 | 2000-3500 |
| Glass | | ≈ 5000 |
| Porcelain | 4500-7000 | ≈ 6000 |
| acrilate | ≈ 200 | ≈ 200 |

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