

Mechanical properties



high-pressure XRD, mechanical tests



iron alloys



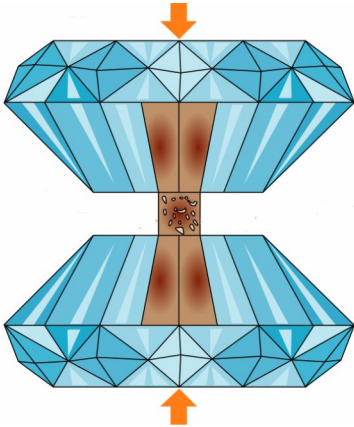
Robert Hooke

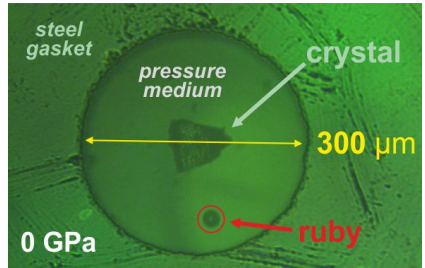
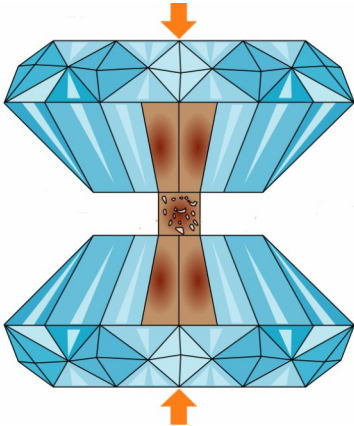


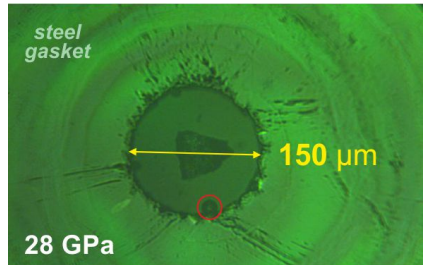
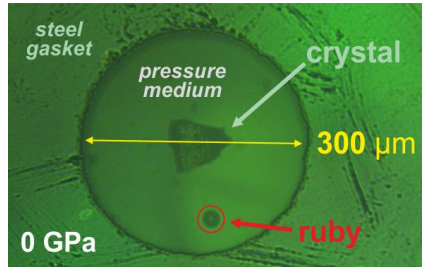
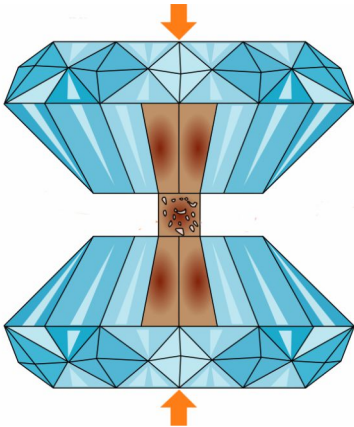


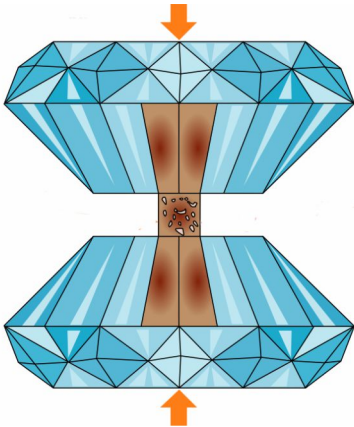
Experimental technique

high-pressure XRD

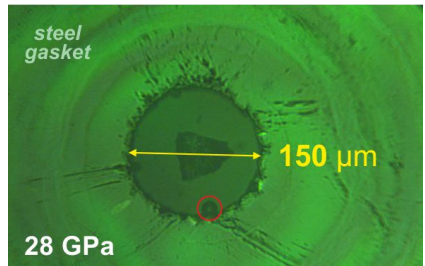
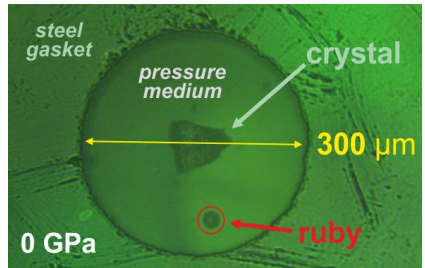


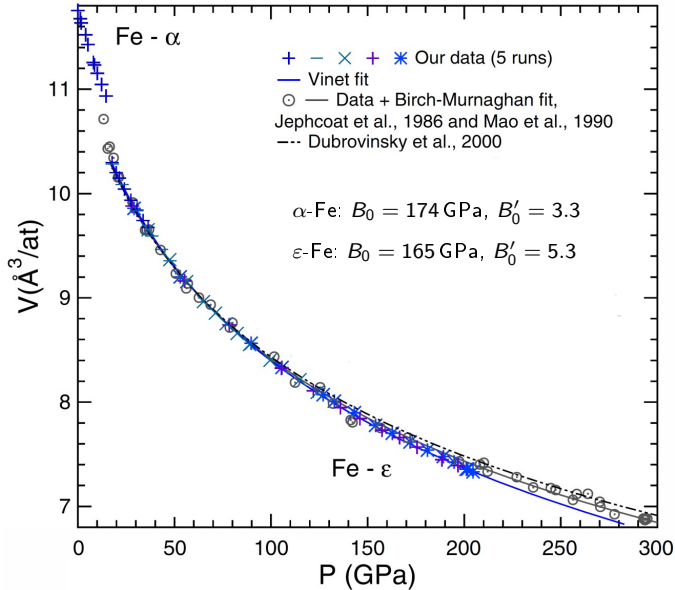


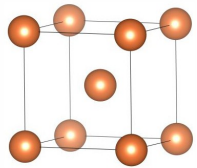
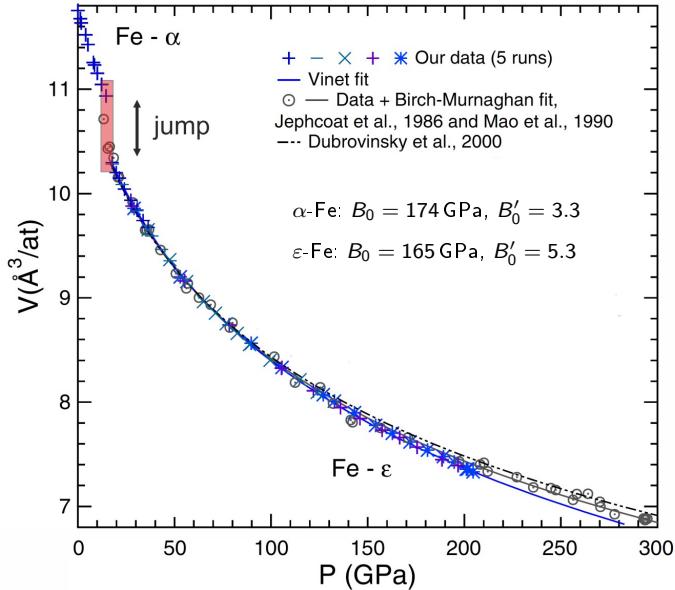




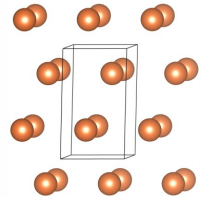
Pressure-transmitting medium allows **hydrostatic** compression
(same pressure from all directions)







$\alpha\text{-Fe}$ (bcc)



$\epsilon\text{-Fe}$ (hcp)



Person

Robert Hooke



Robert Hooke
1635–1703

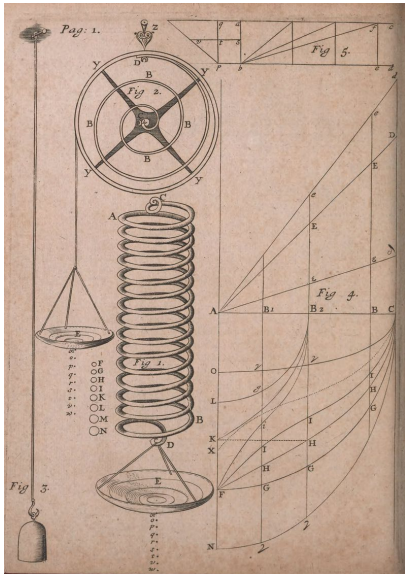
Discovery of microorganisms (1665)



Robert Hooke
1635–1703

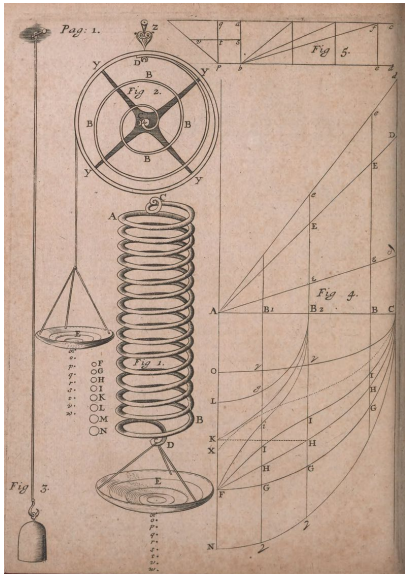
Image credit: National Museum (public domain)

Hooke's law as anagram



ceiinossttuv (published in 1676)

Hooke's law as anagram



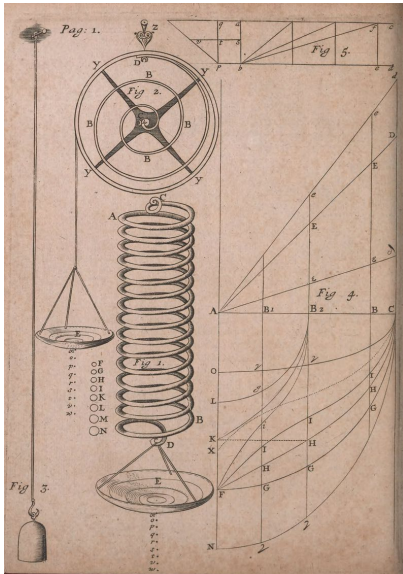
ceiinossttu (published in 1676)

Deciphered in 1678:

Ut tensio, sic vis

("As the extension, so the force")

Hooke's law as anagram

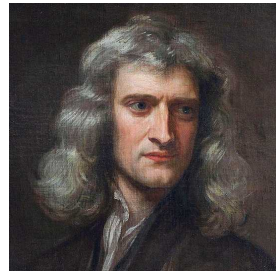


ceiinossttu (published in 1676)

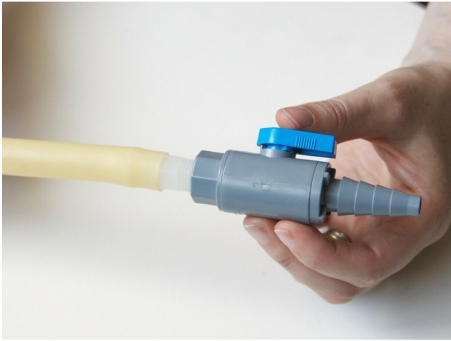
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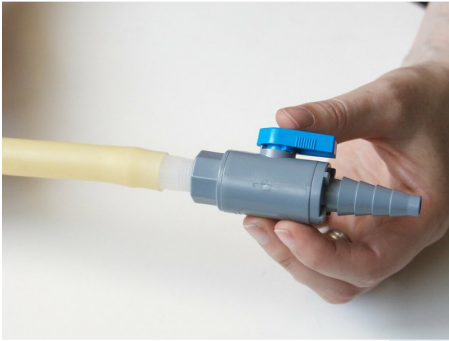
("As the extension, so the force")



competition with Newton
for the law of gravity



Pulling the hose
increases its grip ($\nu > 0$)



Pulling the hose
increases its grip ($\nu > 0$)

Cork ($\nu \simeq 0$)
is good for stoppers



Auxetic materials ($\nu < 0$)

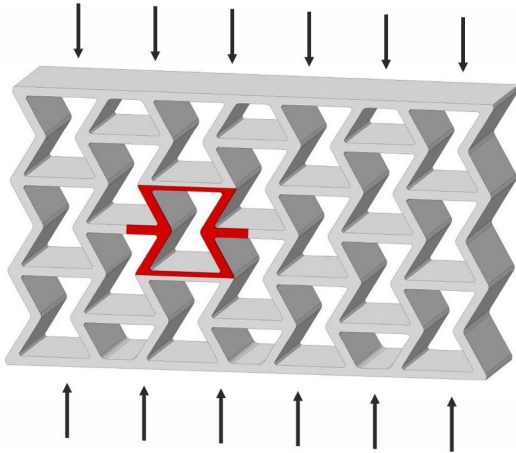
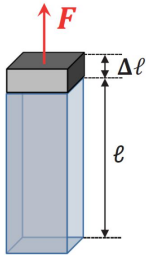
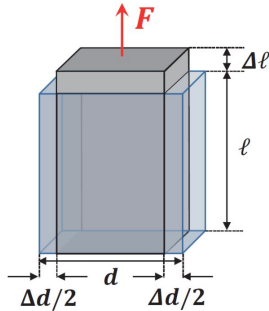


Image credits: Keenan Crane (CC-zero) and J. Dyn. Behavior Mater. 7, 425 (2021)

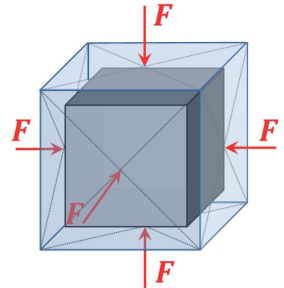
Types of stress



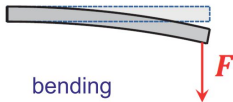
uniaxial pressure



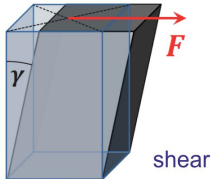
lateral stress



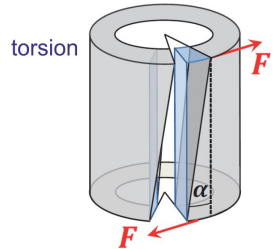
hydrostatic compression



bending



shear



torsion



Experimental technique

mechanical tests

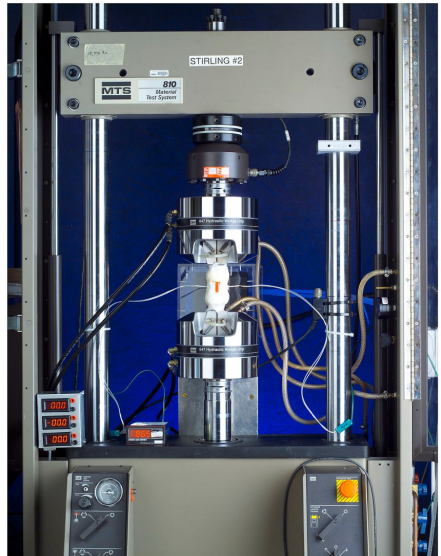
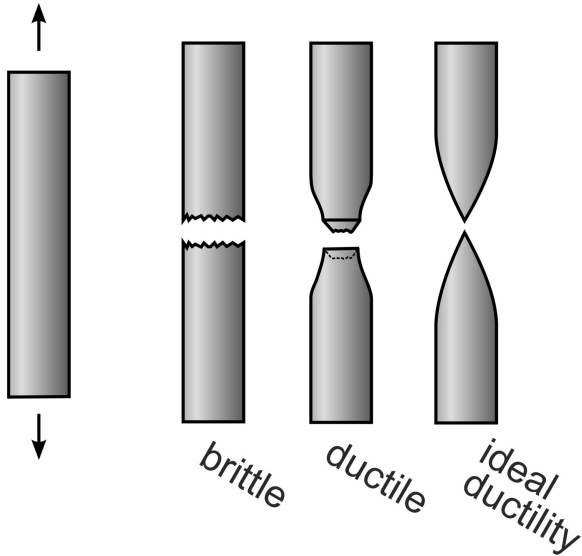


Image credit: Smial (CC-BY-SA) and NASA (public domain)





AlMgSi alloy is **ductile**

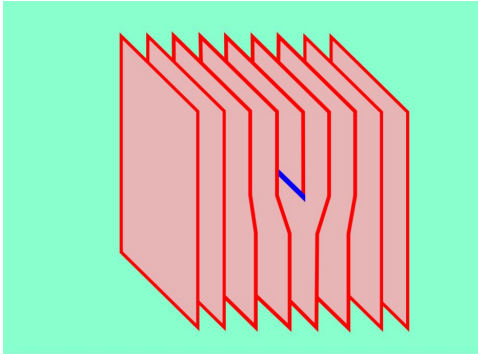


cast iron is **brittle**

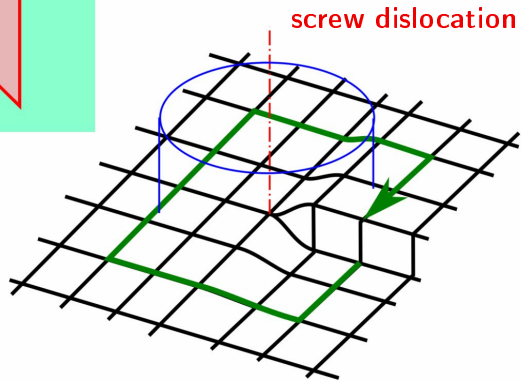
Image credit: Sigmund, Anonimski (CC-BY-SA)



Gold is the most **malleable** metal



edge dislocation



Origin of plastic deformation

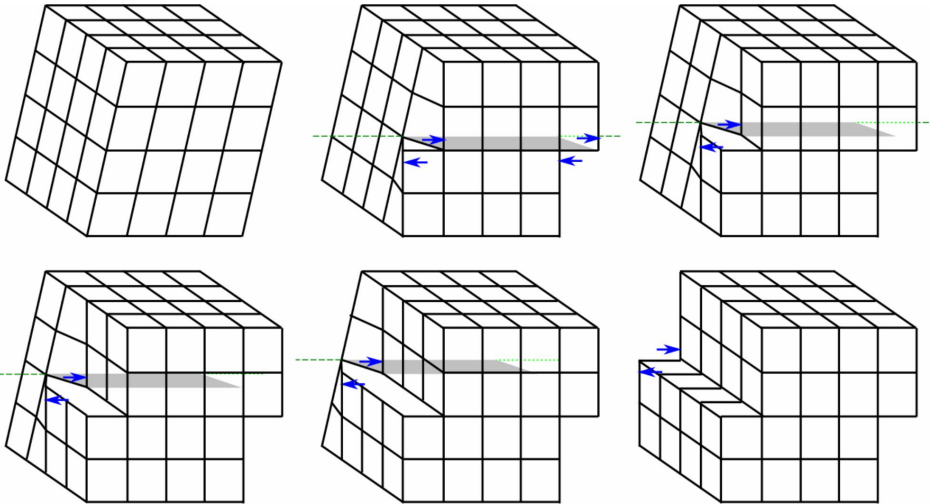
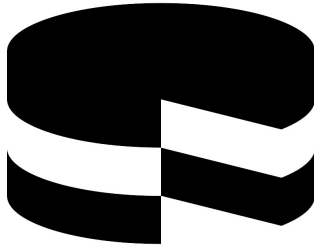


Image credit: Ciang (CC-BY-SA)



Material

iron alloys

Main iron products



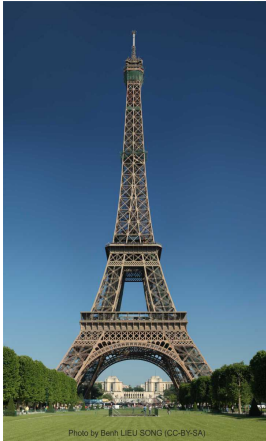
Cast iron
($> 2\%$ carbon)
hard and brittle



Wrought iron
($< 0.08\%$ carbon)
ductile and softer



Cast iron
($> 2\%$ carbon)
hard and brittle



Wrought iron
($< 0.08\%$ carbon)
ductile and softer



Steel
($< 2\%$ carbon)
optimal



Cast iron
($> 2\%$ carbon)
hard and brittle

Phase diagram

