

# MATERIAL PROPERTIES (SIFAT-SIFAT BAHAN)

Materi kuliah bahan teknik

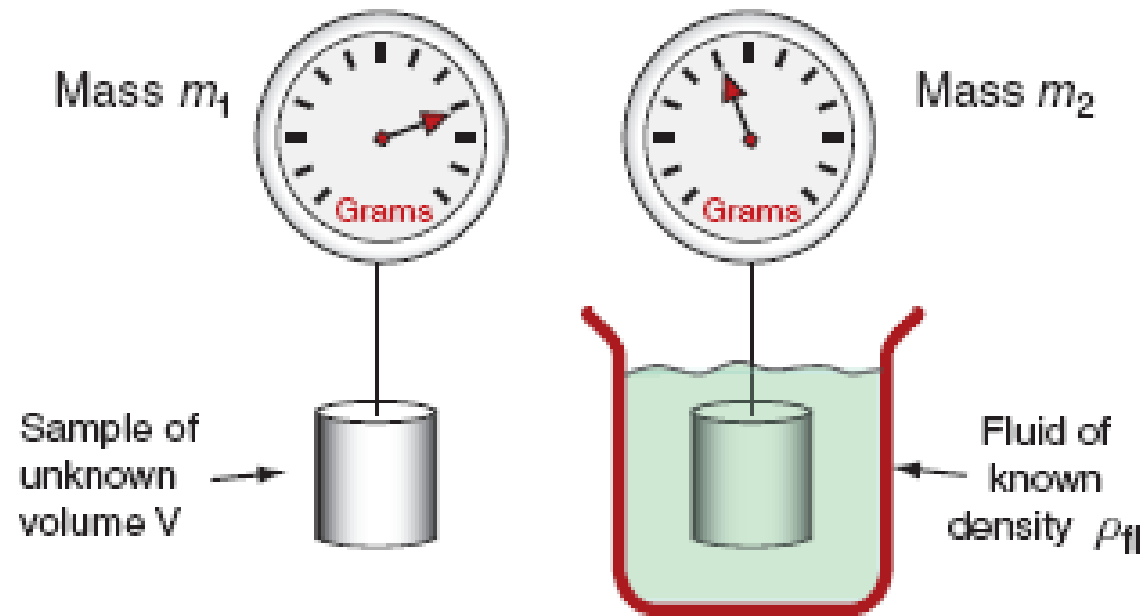
# Sifat-sifat material

- Ciri-ciri atau kondisi yang dimiliki oleh suatu material yang meliputi :
  - Phisical
  - Mechanical
  - Thermal
  - Electrical
  - Magnetic
  - Enviromental
  - Production
  - Aesthetic
  - Economic

# Classes of property

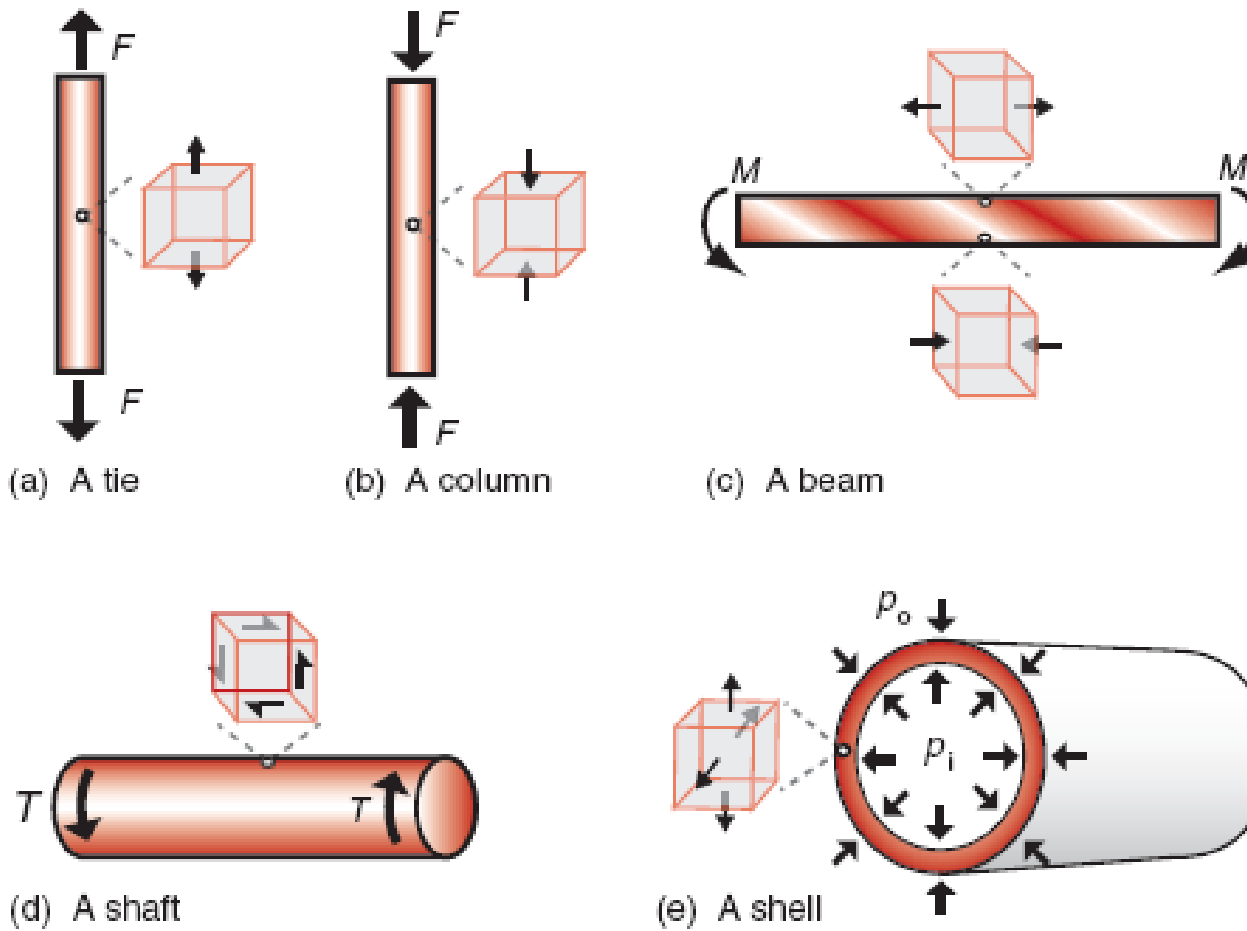
No	Ability	Properties
1	Economic	<ul style="list-style-type: none"> <li>• Price and availability</li> <li>• Recyclability</li> </ul>
2	General Physical	<ul style="list-style-type: none"> <li>• Density</li> </ul>
3	Mechanical	<ul style="list-style-type: none"> <li>• Modulus</li> <li>• Yield and tensile strength</li> <li>• Hardness</li> <li>• Fracture toughness</li> <li>• Fatigue strength</li> <li>• Creep strength</li> <li>• Damping</li> </ul>
4	Thermal	<ul style="list-style-type: none"> <li>• Thermal conductivity</li> <li>• Specific heat</li> <li>• Thermal expansion coefficient</li> </ul>
5	Electrical and Magnetic	<ul style="list-style-type: none"> <li>• Resistivity</li> <li>• Dielectric constant</li> <li>• Magnetic permeability</li> </ul>
6	Environmental Interaction	<ul style="list-style-type: none"> <li>• Oxidation</li> <li>• Corrosion</li> <li>• Wear</li> </ul>
7	Production	<ul style="list-style-type: none"> <li>• Ease of manufacture</li> <li>• Joining</li> <li>• Finishing</li> </ul>
8	Aesthetic	<ul style="list-style-type: none"> <li>• Colour</li> <li>• Texture</li> <li>• Feel</li> </ul>

# Density (berat jenis)

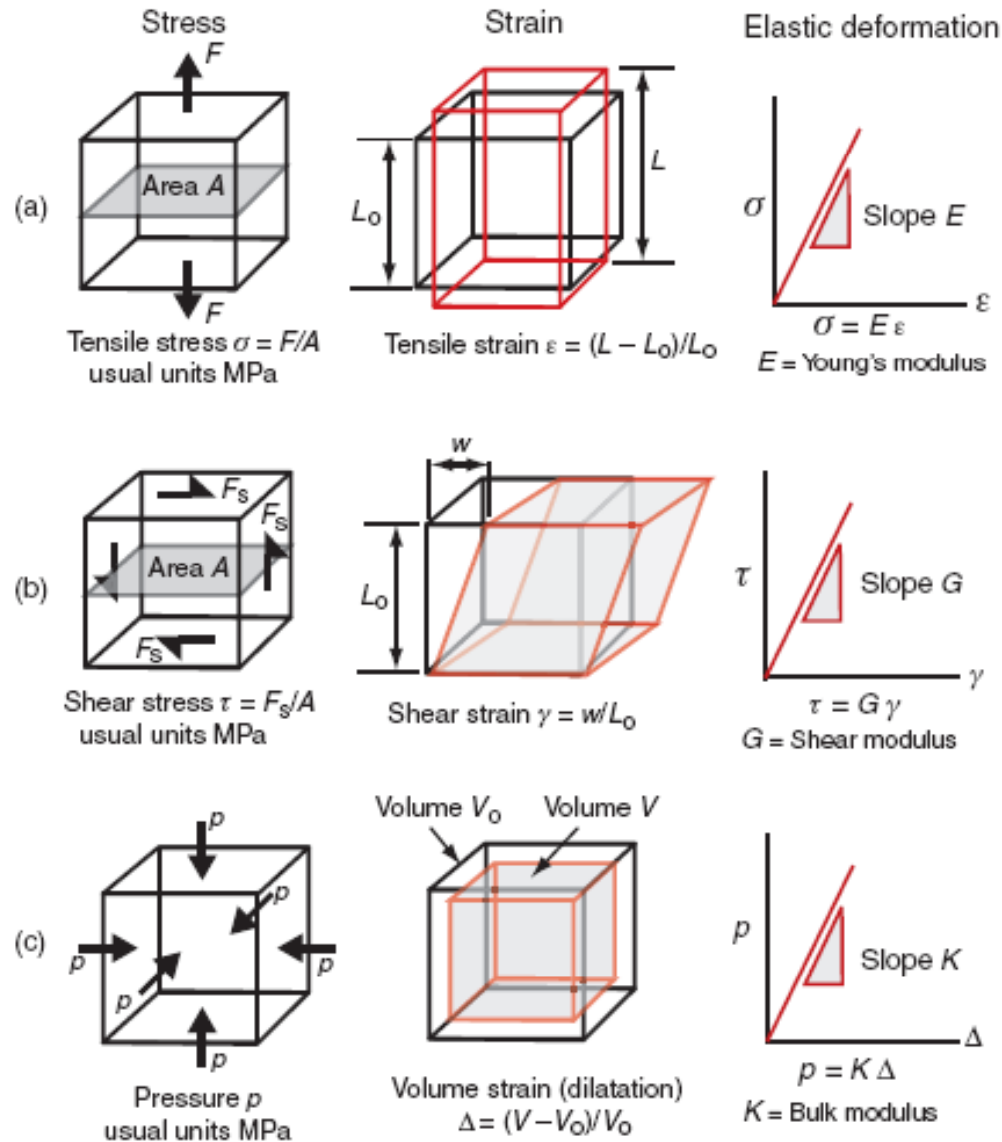


$$\text{Density } \rho = \rho_{fl} \frac{m_1}{m_1 - m_2}$$

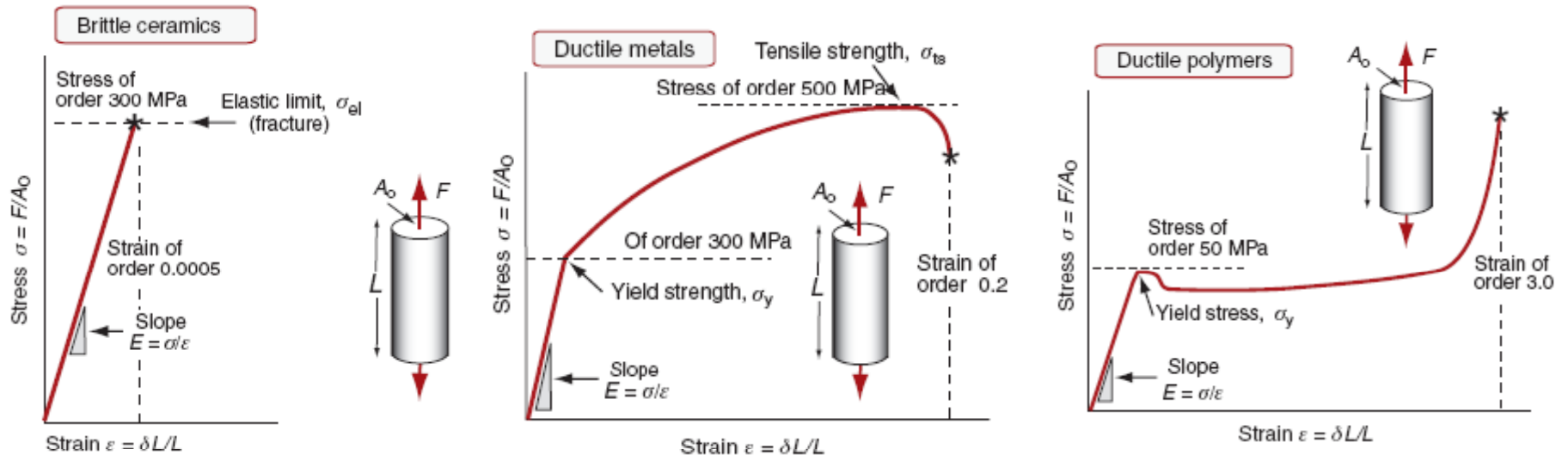
# Modes of loading and states of stress



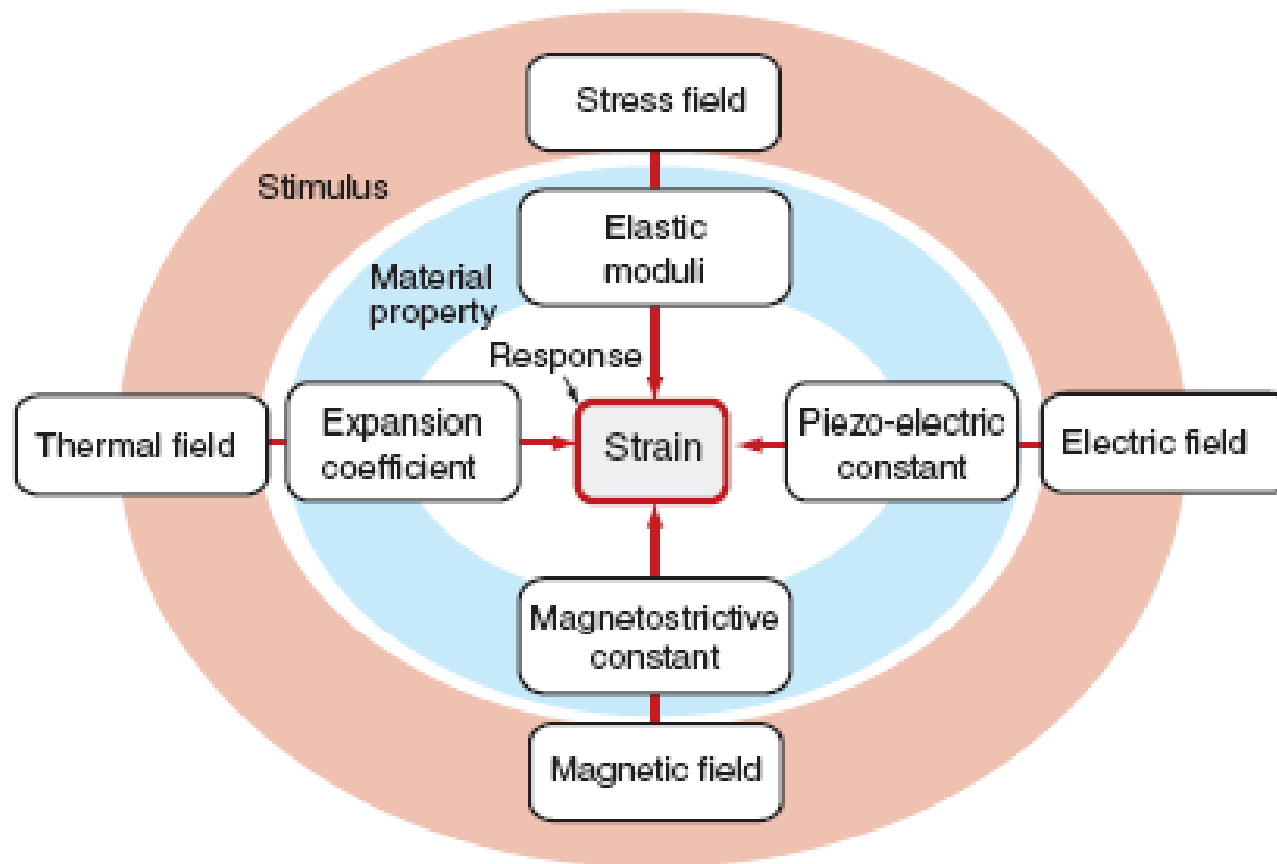
# The definitions of stress, strain and elastic moduli



# Tensile stress–strain curves for ceramics, metals and polymers.

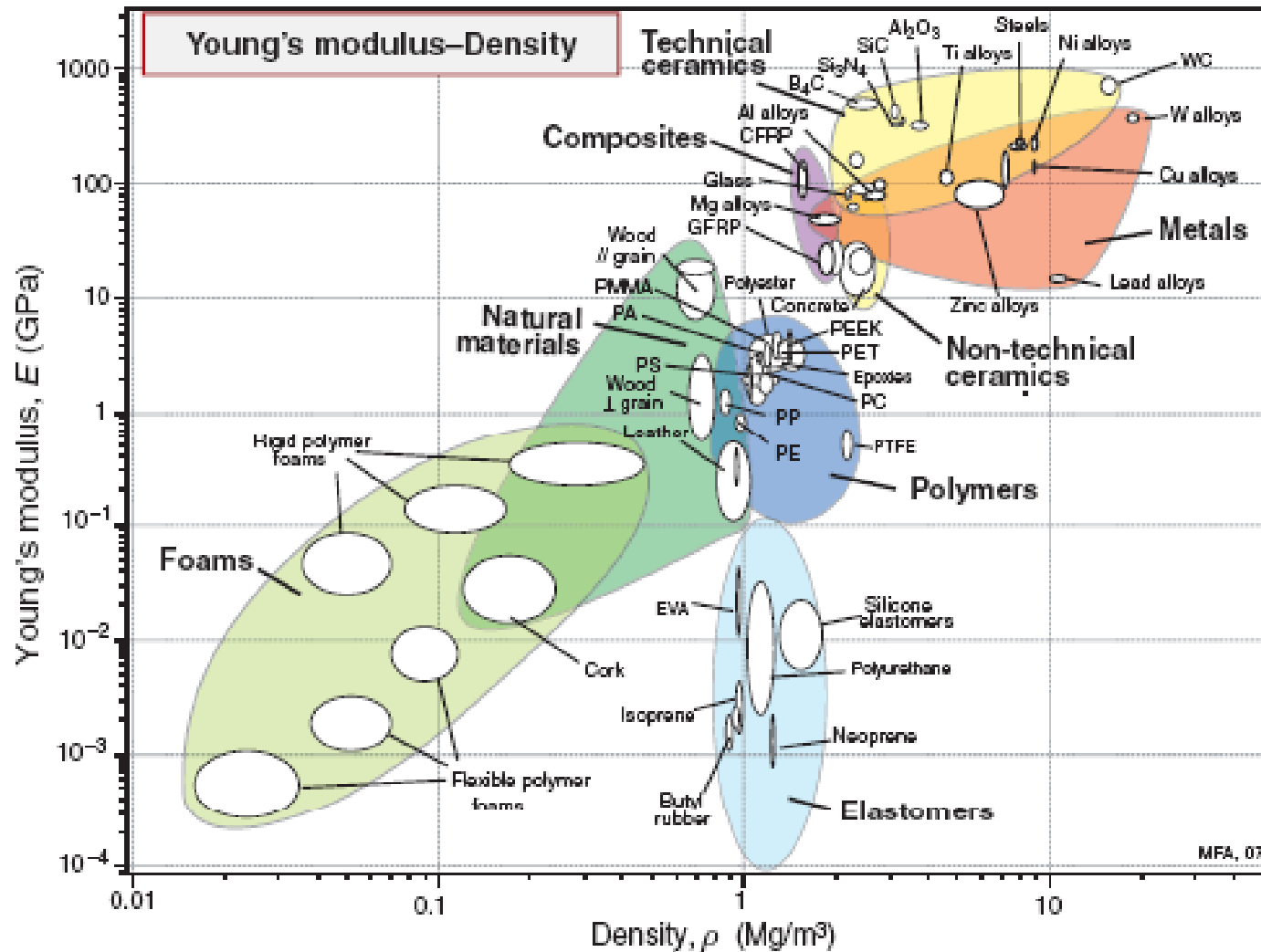


# Stimuli leading to strain

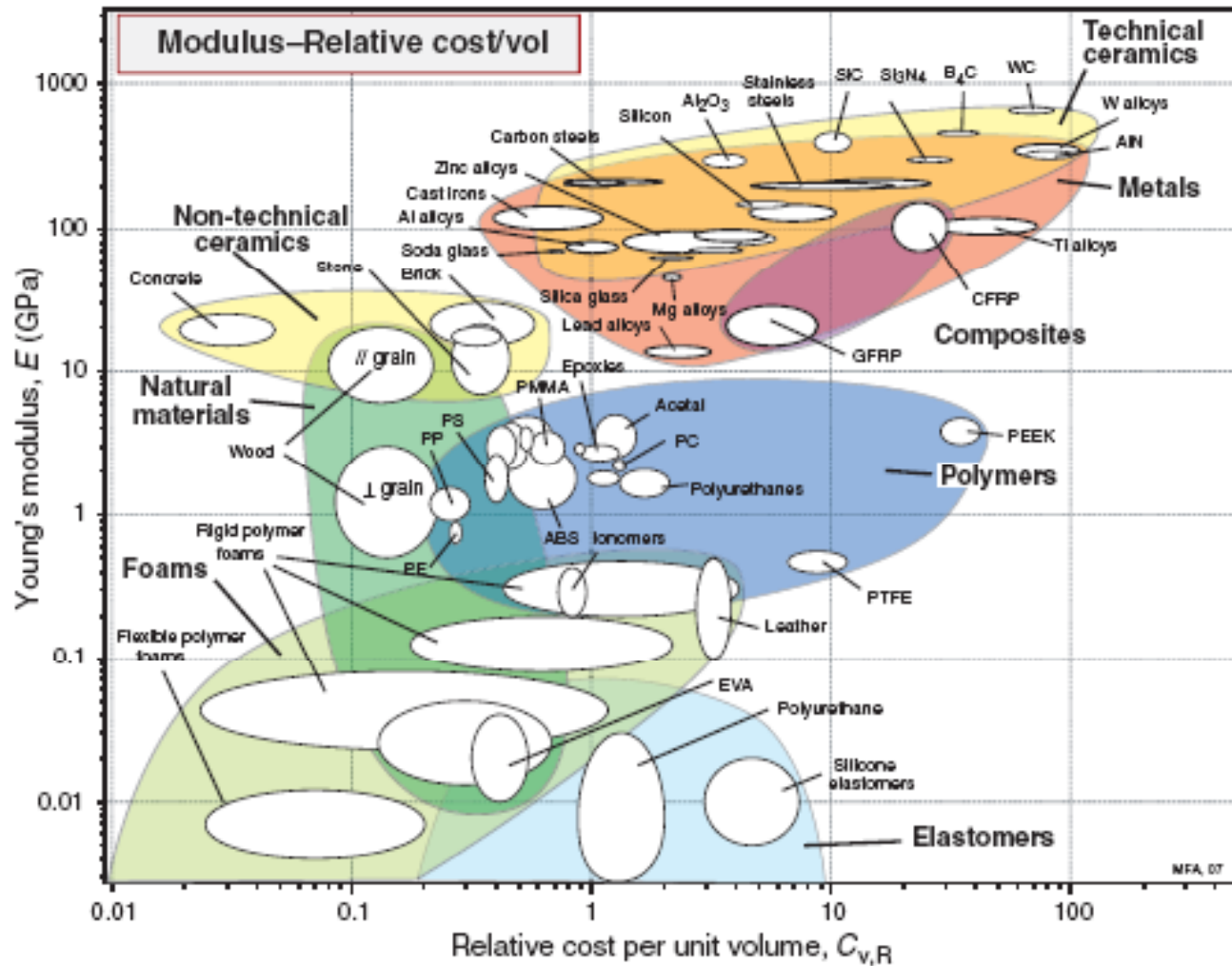




# The modulus–density chart.

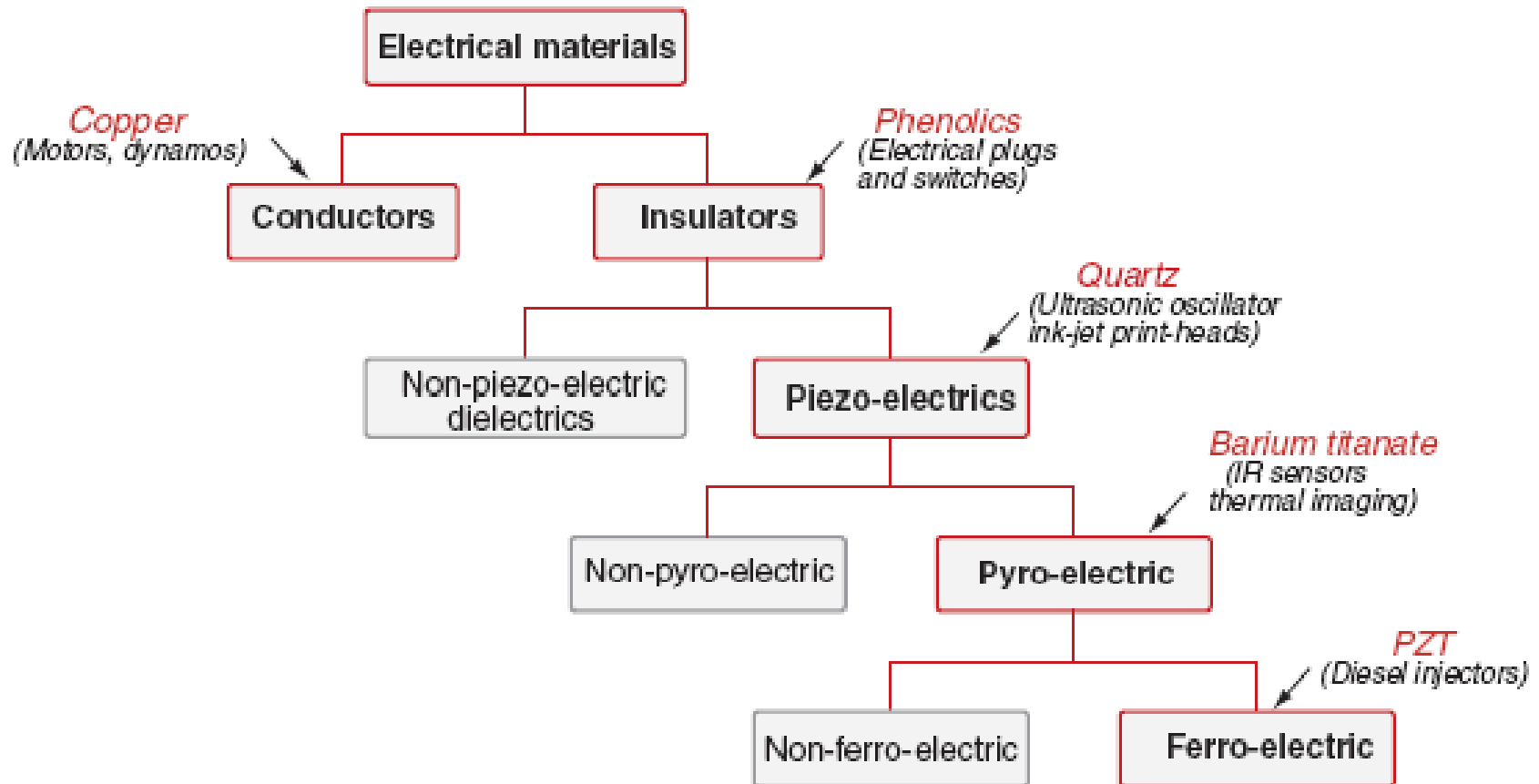


The modulus–relative cost chart. (The CES software contains material prices, regularly updated.)

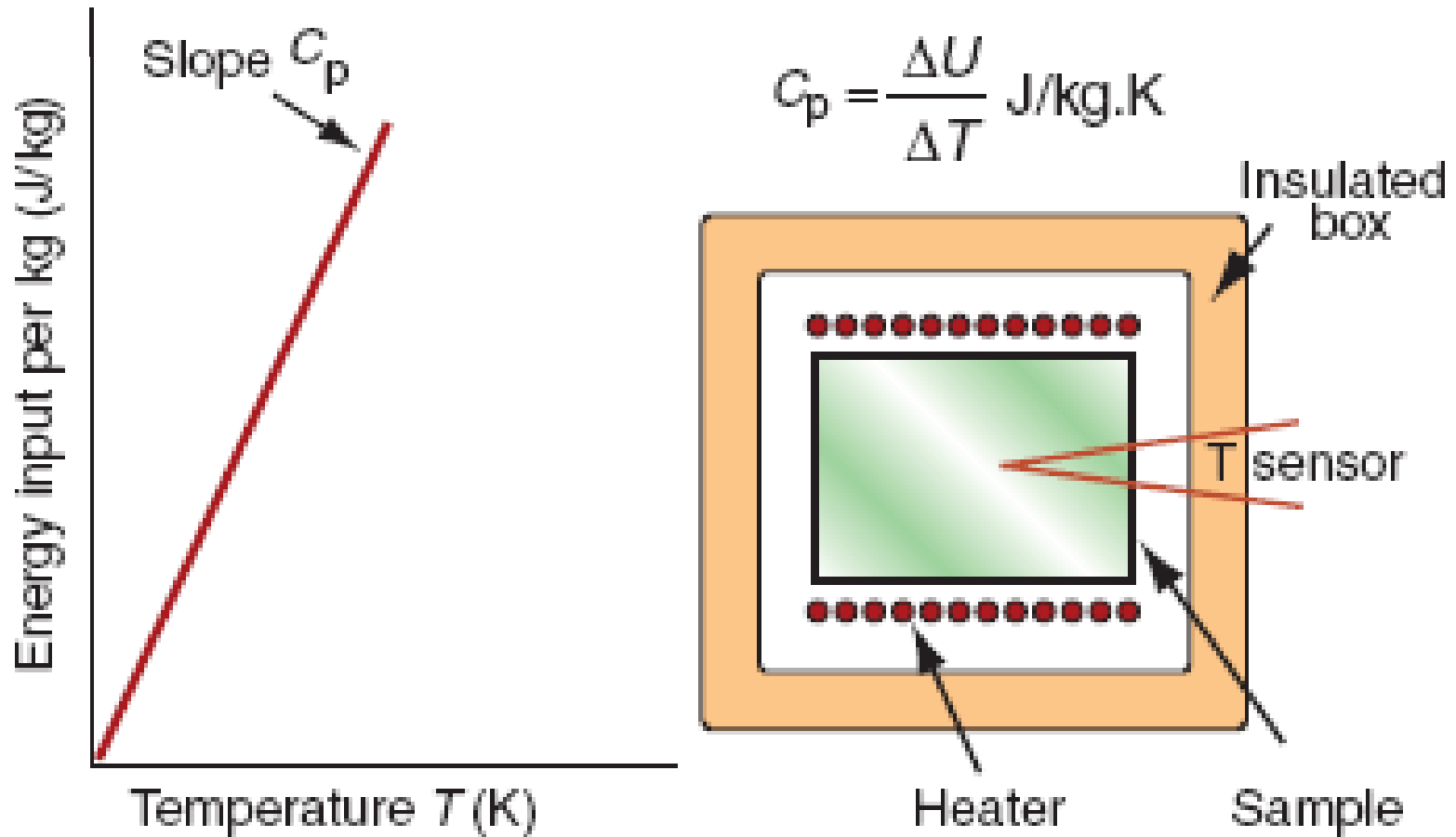




# The hierarchy of electrical behavior

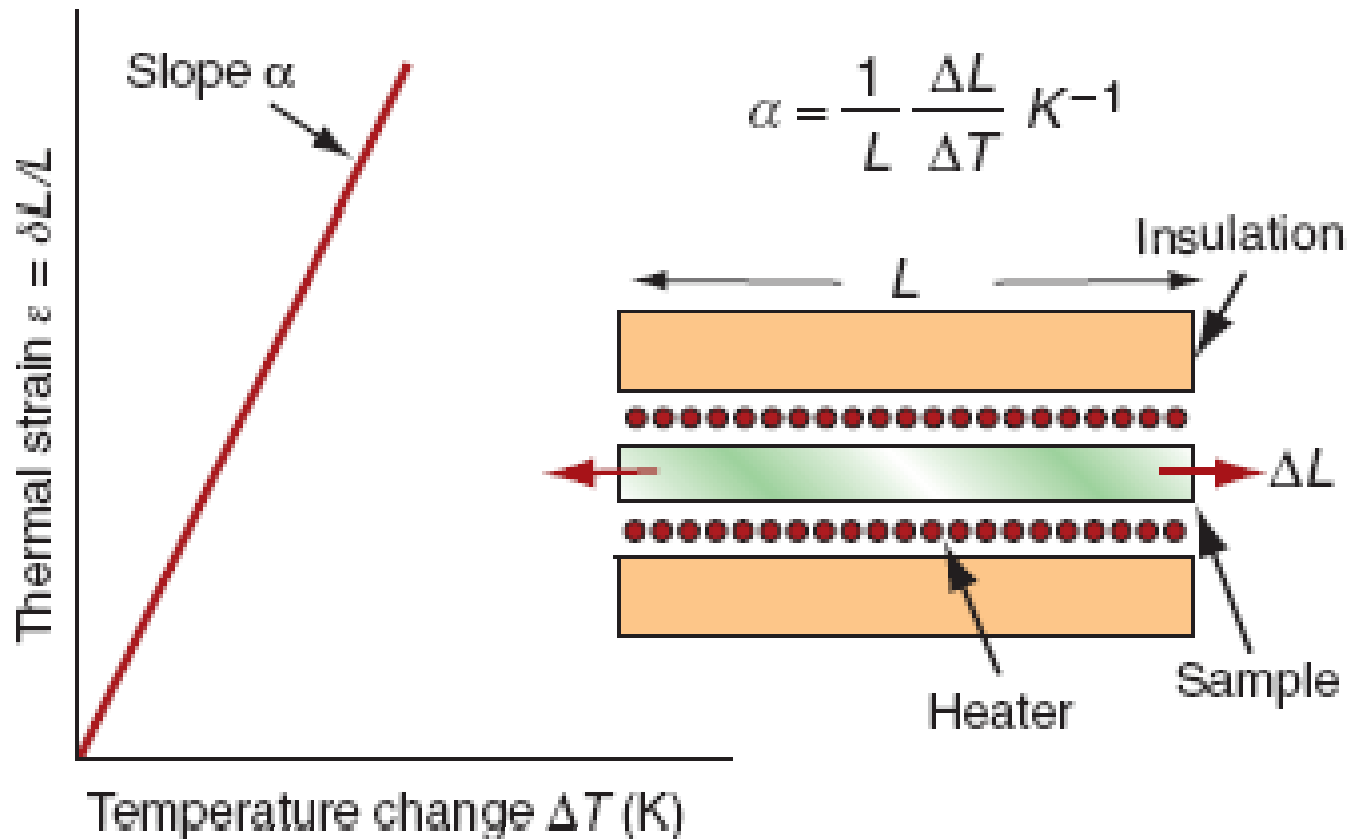


Measuring heat capacity,  $C_p$ . *Its units are J/kg.K.*



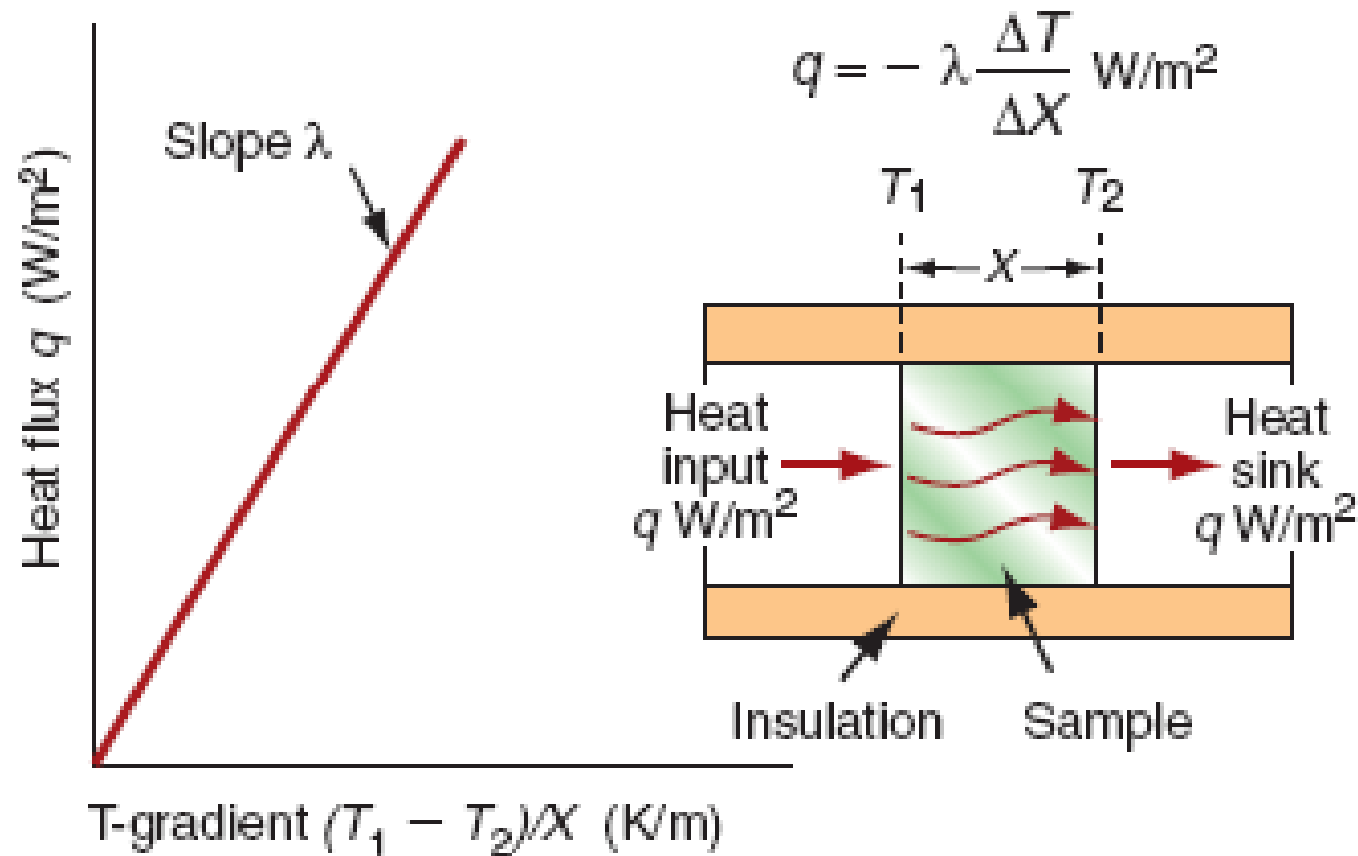
Measuring the thermal expansion coefficient,  $\alpha$ .

*Its units are 1/K or, more usually, 10<sup>6</sup>/K (microstrain/K).*



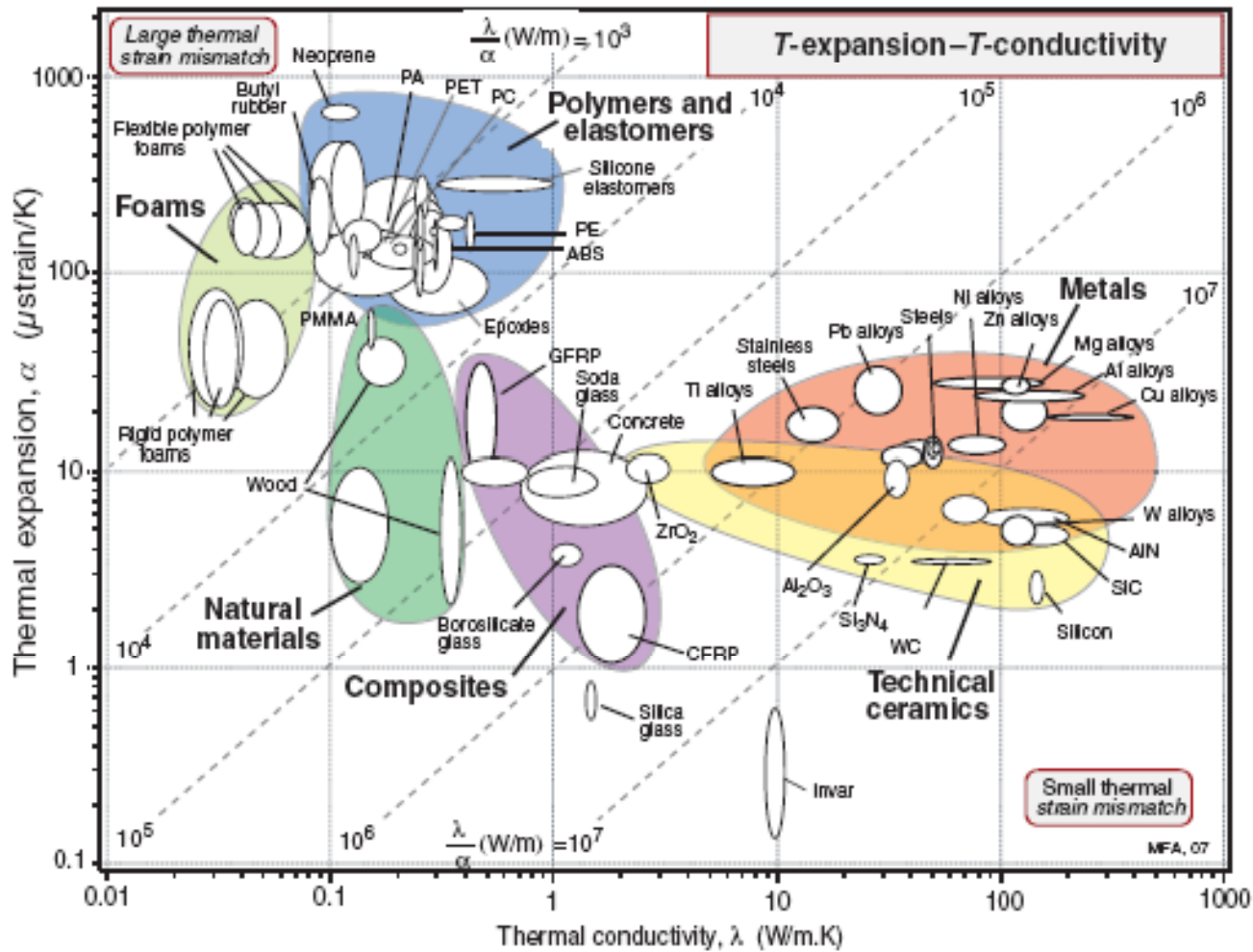
# Measuring the thermal conductivity, $\lambda$ .

*Its units are  $W/m K$ .*



The linear expansion coefficient,  $\alpha$ , plotted against the thermal conductivity,  $\lambda$ .

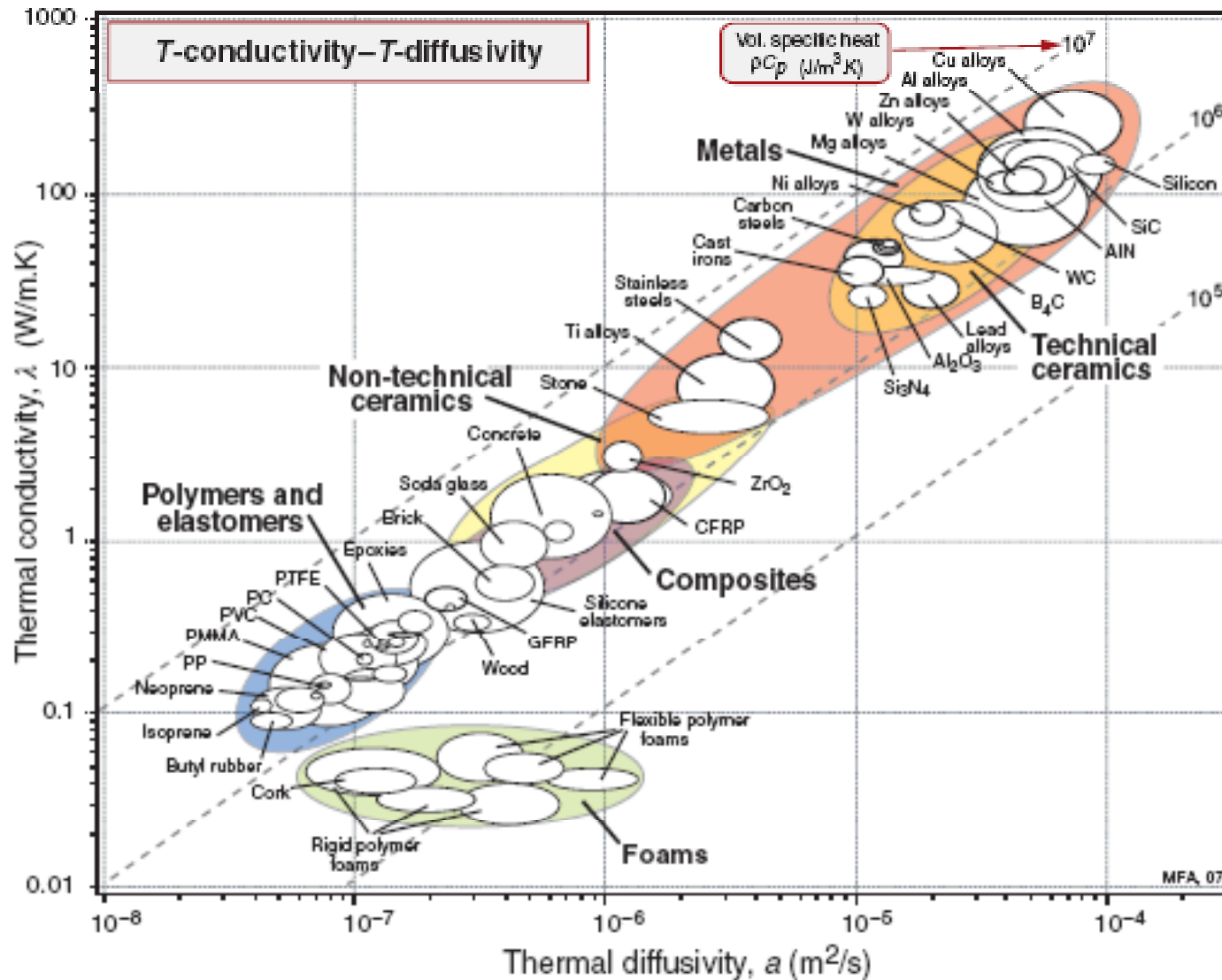
The contours show the thermal distortion parameter  $\lambda/\alpha$ .



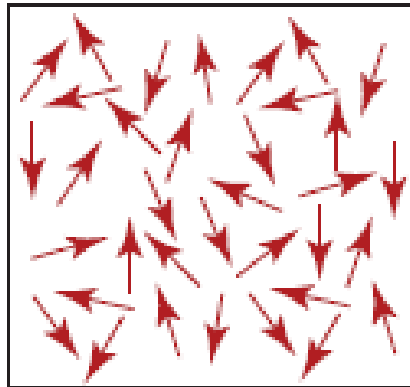


The thermal conductivity,  $\lambda$ , plotted against the thermal diffusivity,  $a$   $\lambda/\rho C_p$ .

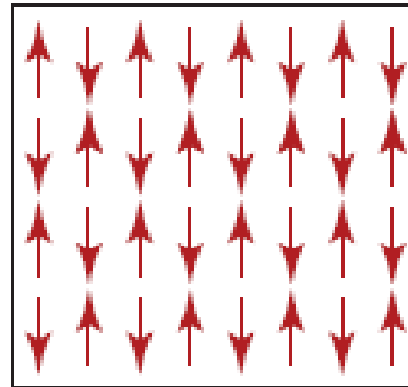
The contours show the specific heat per unit volume  $\rho C_p$ .



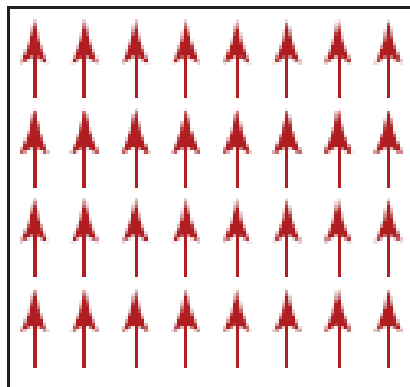
# Types of magnetic behavior



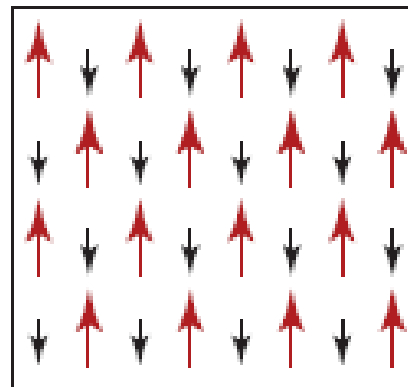
(a) Paramagnetic



(b) Anti-ferro-magnetic

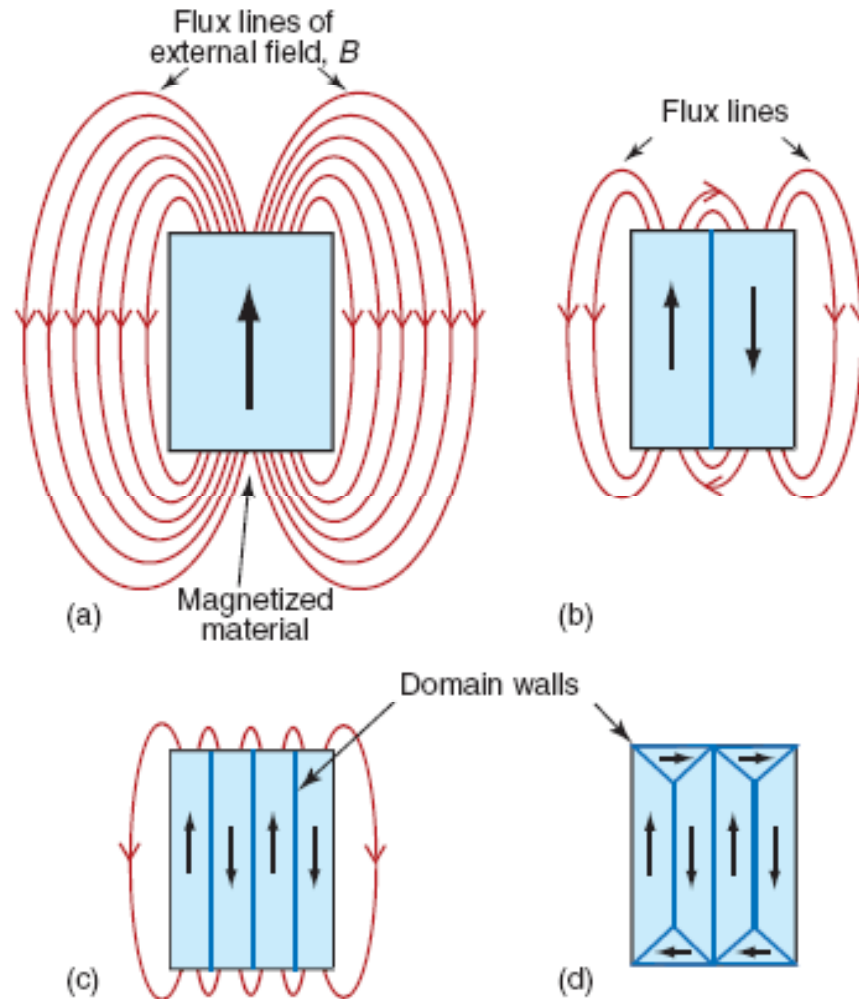


(c) Ferro-magnetic

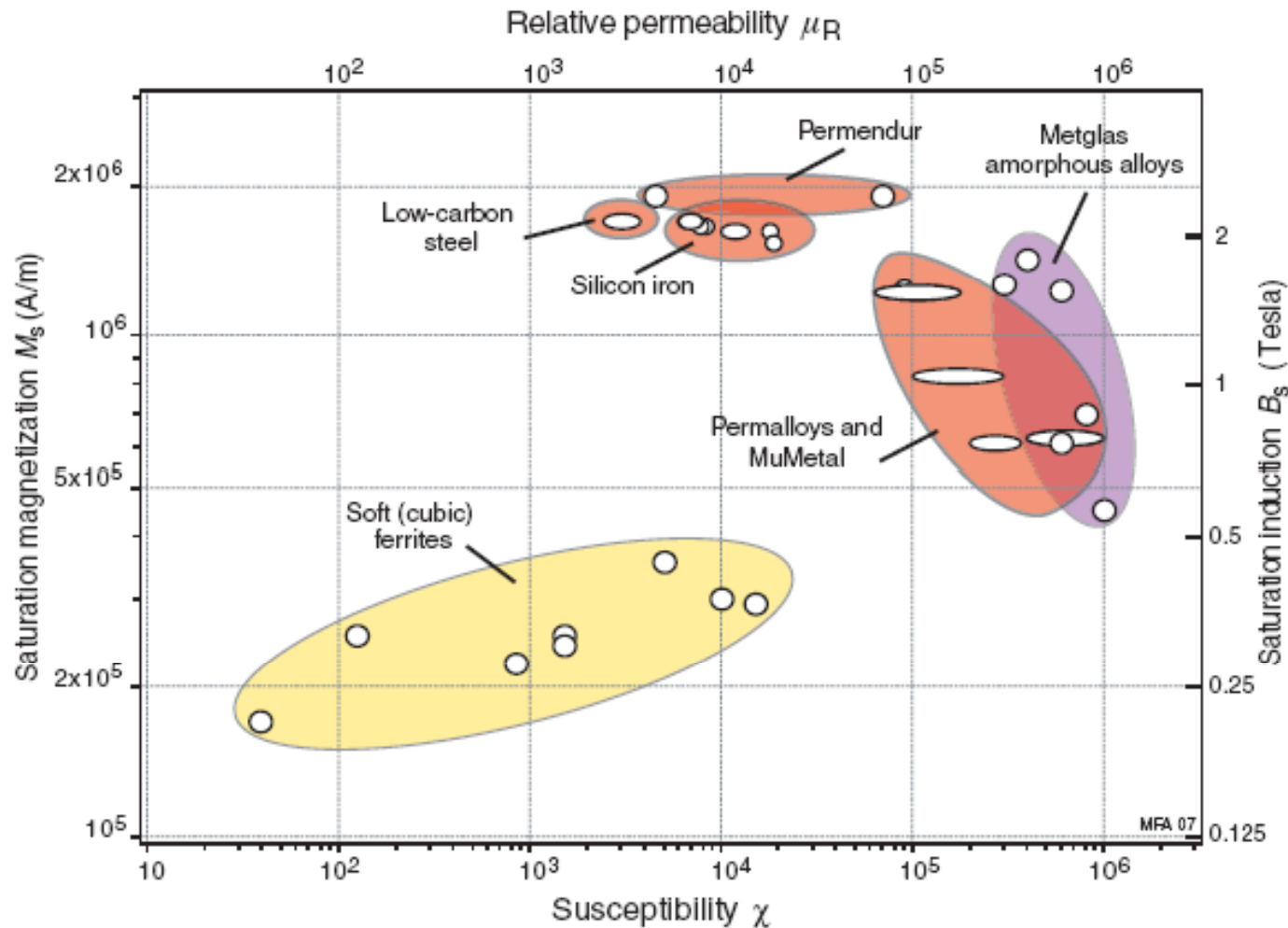


(d) Ferri-magnetic

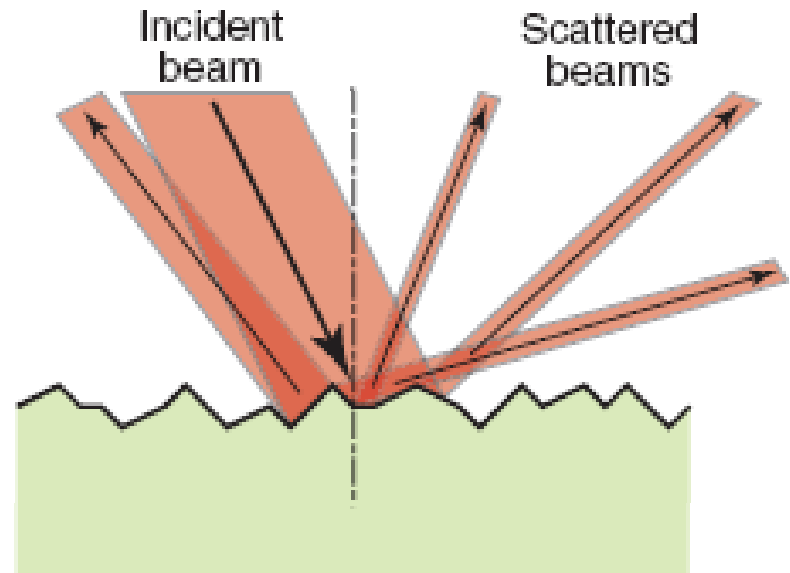
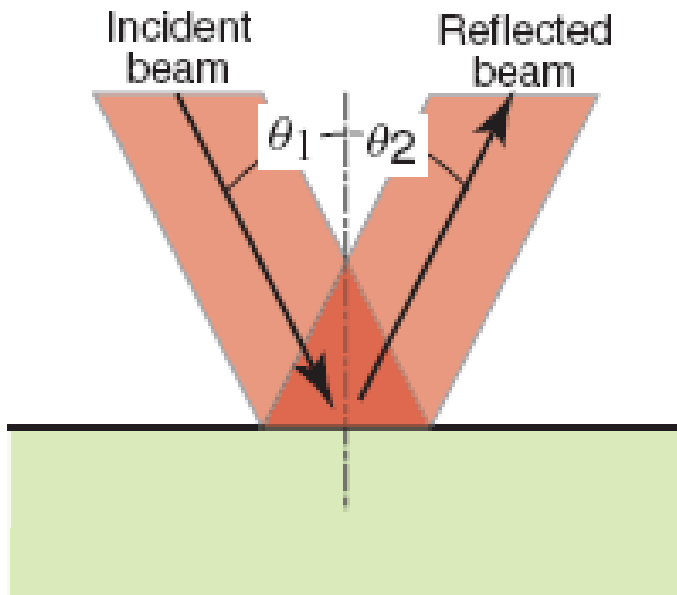
Domains allow a compromise: the cancellation of the external field while retaining magnetization of the material itself. The arrows show the direction of magnetization.



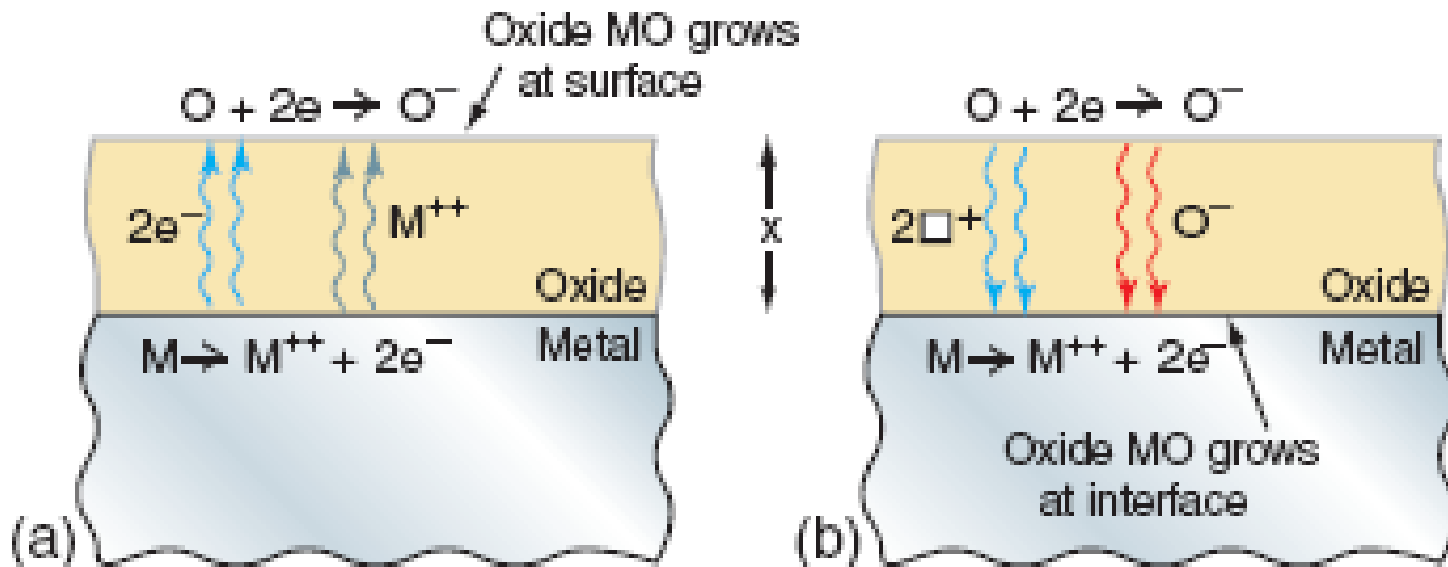
# Saturation magnetization and susceptibility for soft magnetic materials



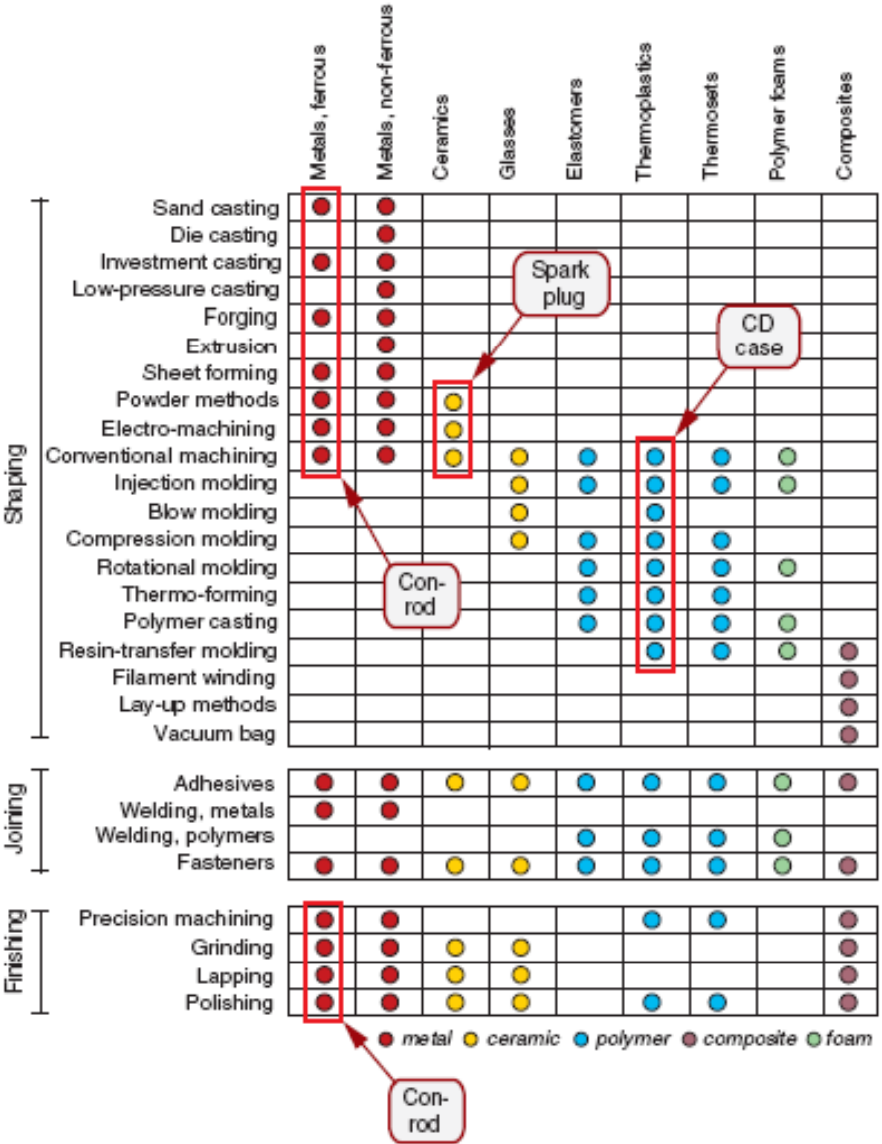
Optically flat, reflective surfaces give specular reflection, such that  $\theta_1 = \theta_2$ .



Oxidation mechanisms. (a) Growth by metal diffusion and electron conduction  
 (b) Growth by diffusion of oxygen and holes



# The material-process compatibility matrix for shaping, joining and finishing processes color coded by material



# The classification of shape

