

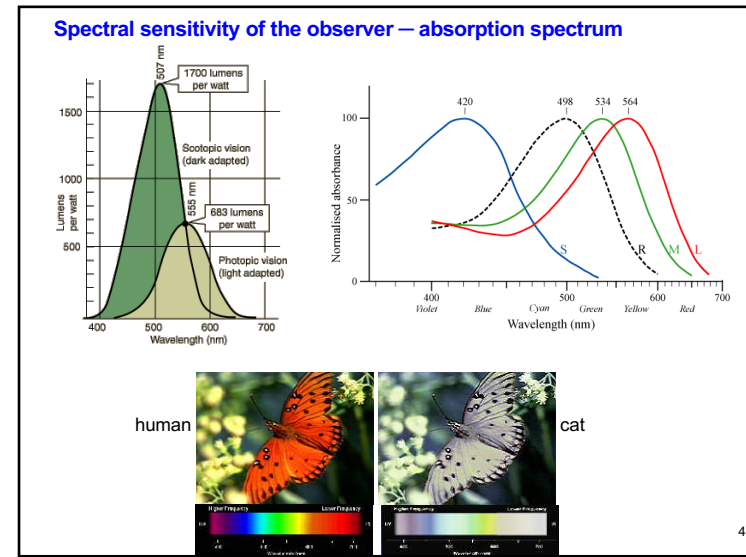
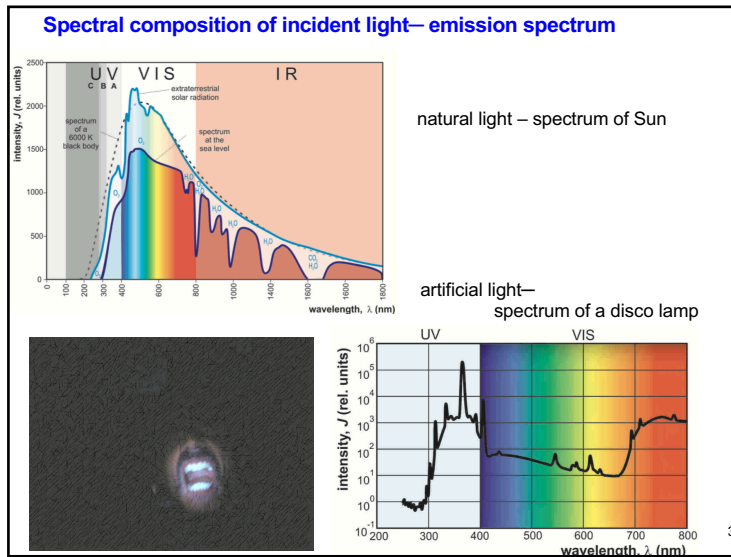
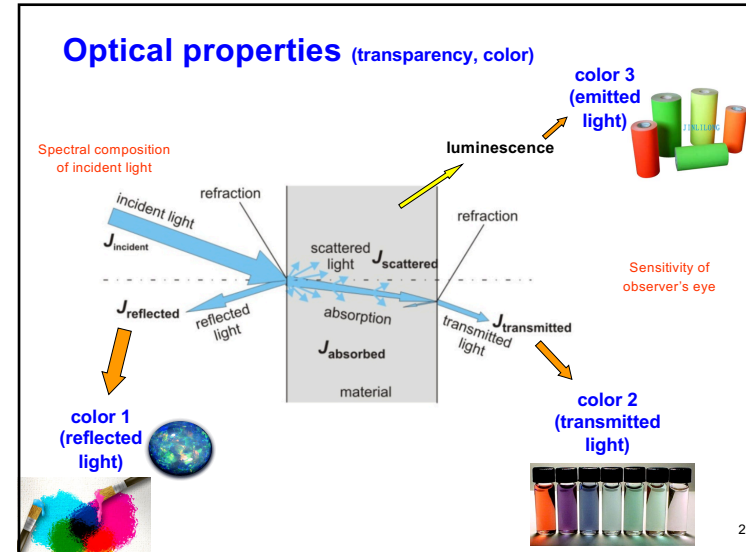
Physical bases of dental materials

11.

Optical properties.
Comparative summary.

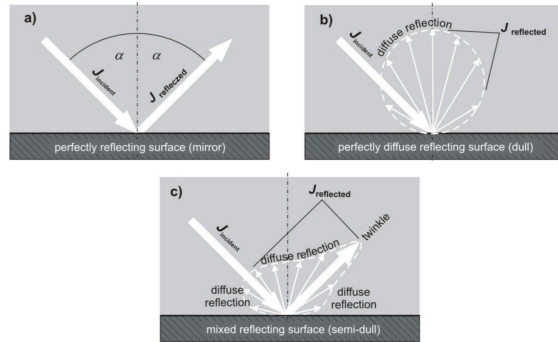
e-book chapters:
20, 21

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Interaction of light with matter \Rightarrow color

1. Reflection:



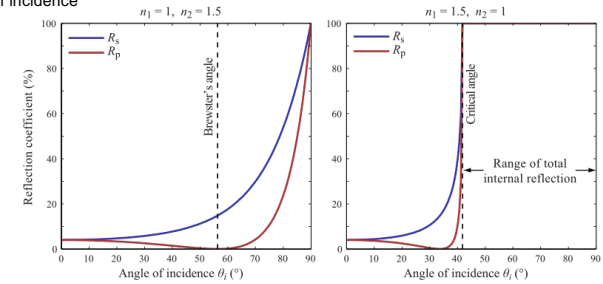
Spectral reflectance $\rho(\lambda)$:

$$\rho_\lambda = \frac{J_{\text{reflected}}}{J_{\text{incident}}}$$

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ρ depends on:

- angle of incidence



- type of materials (refractive indices)

when angle of incidence is zero:

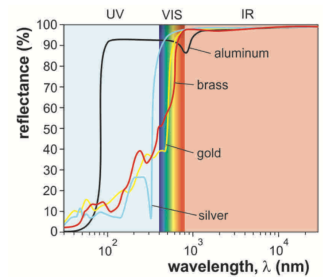
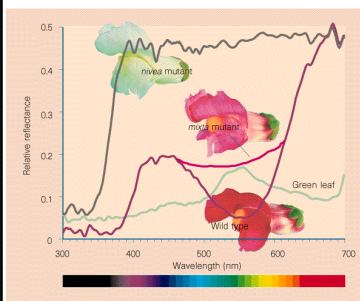
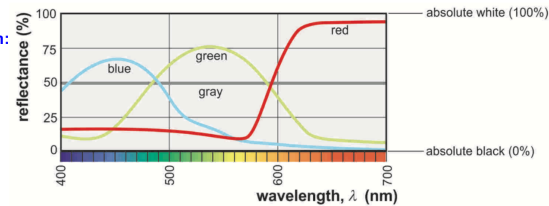
$$\rho = \left(\frac{n_1 - n_2}{n_1 + n_2} \right)^2$$

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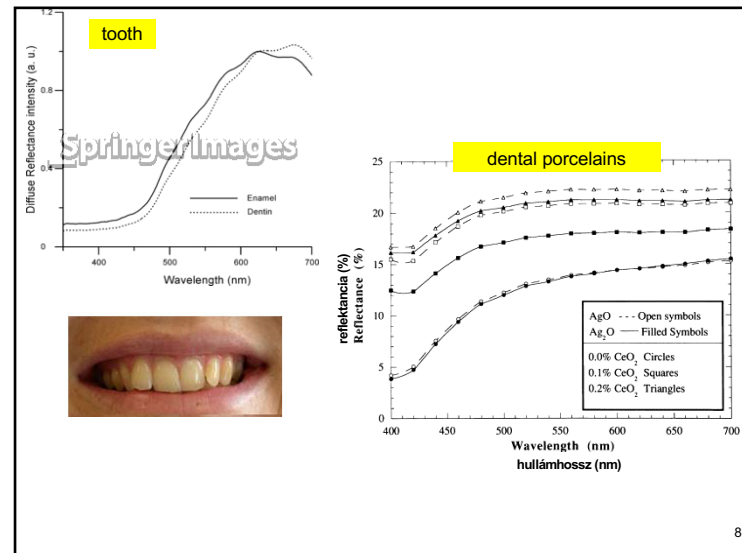
- wavelength

Reflection spectrum:

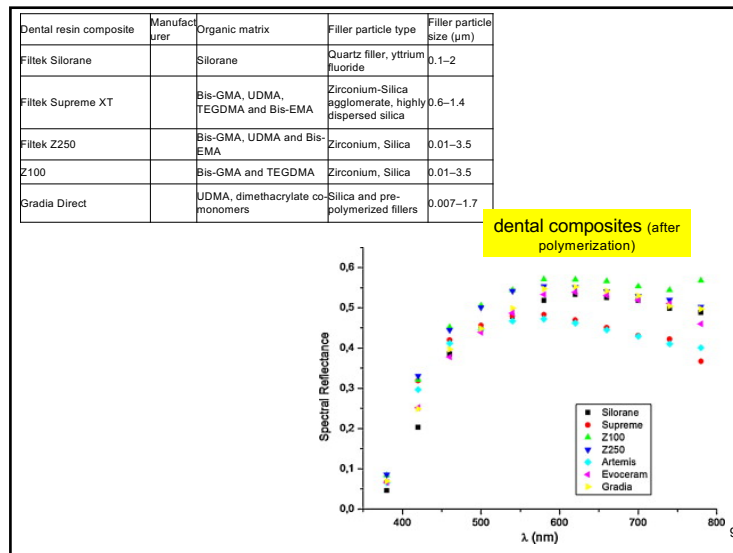
color 1
(reflected light)



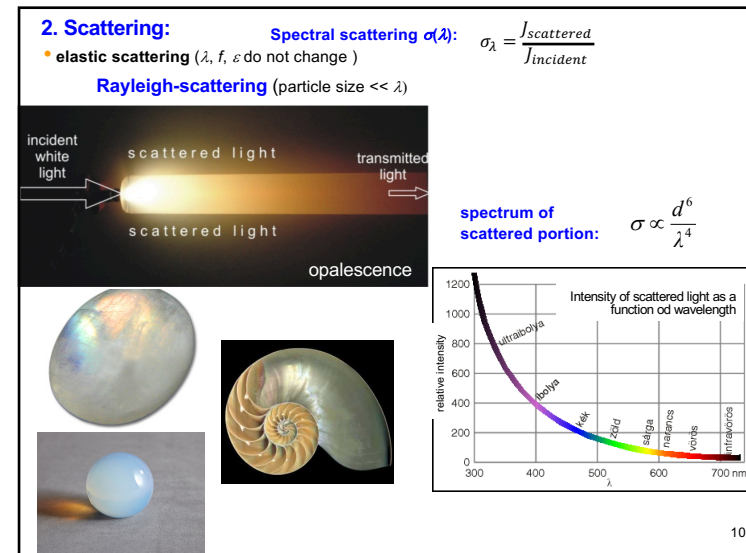
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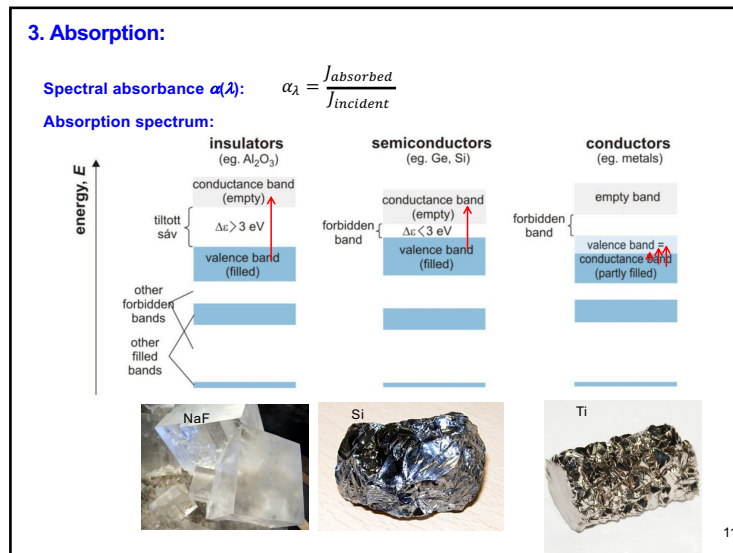
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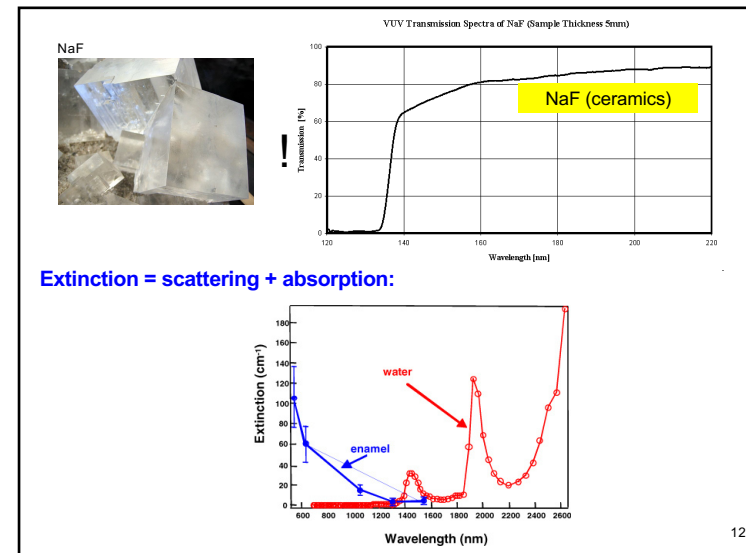
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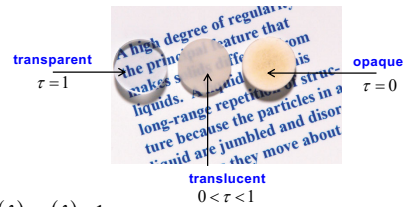


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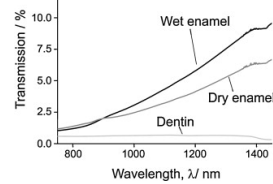
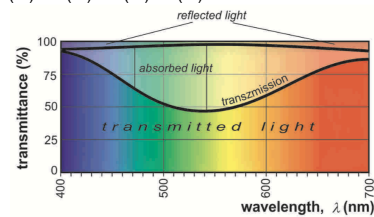
4. Transmission:

Spectral transmittance $\tau(\lambda)$:

$$\tau_{\lambda} = \frac{I_{\text{transmitted}}}{I_{\text{incident}}}$$

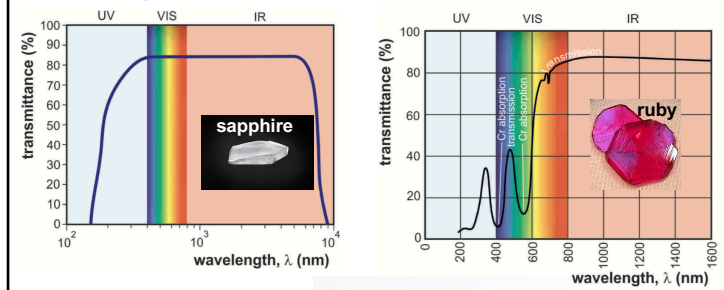


$$\rho(\lambda) + \sigma(\lambda) + \alpha(\lambda) + \tau(\lambda) = 1$$



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Transmission spectrum:

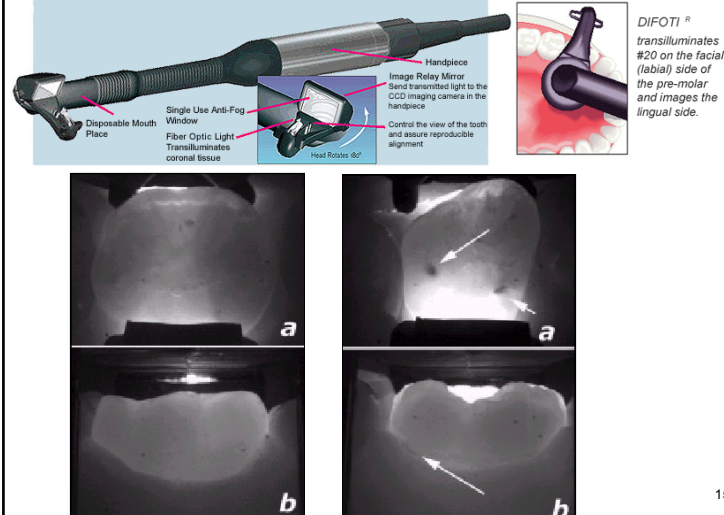


color 2
(transmitted light)



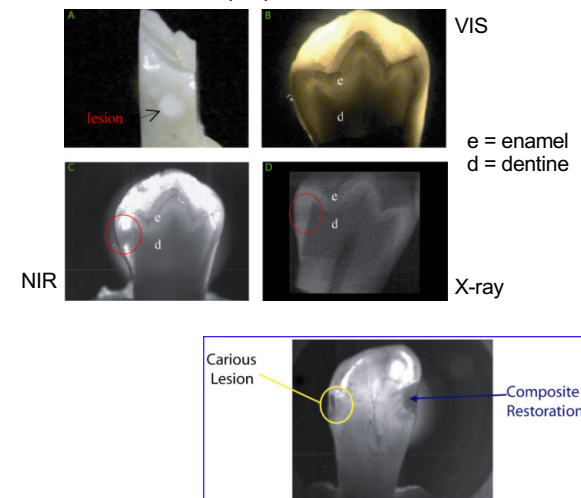
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DIFOTI® (Digital Imaging Fiber-Optic Trans-Illumination)



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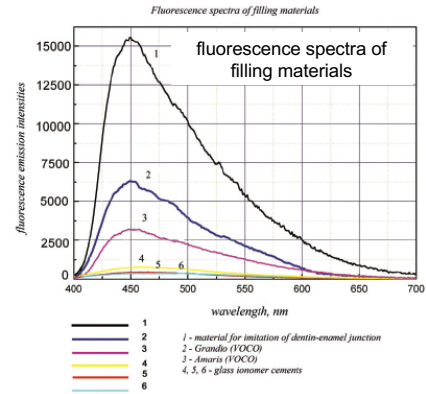
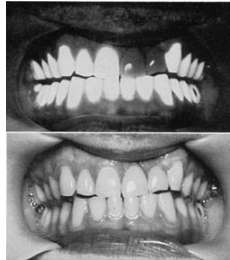
Trans-illumination in near infrared (NIR)



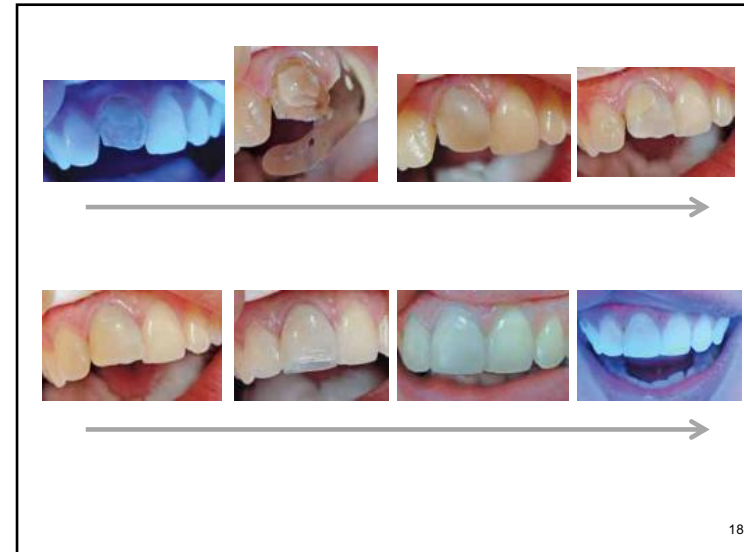
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5. Fluorescence

fluorescence of enamel

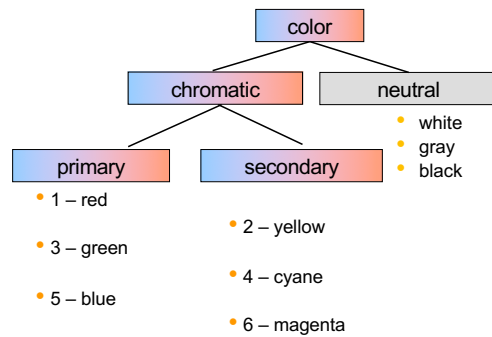


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Color

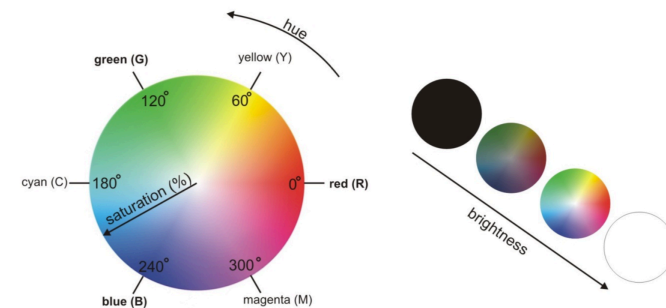


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color coordinates

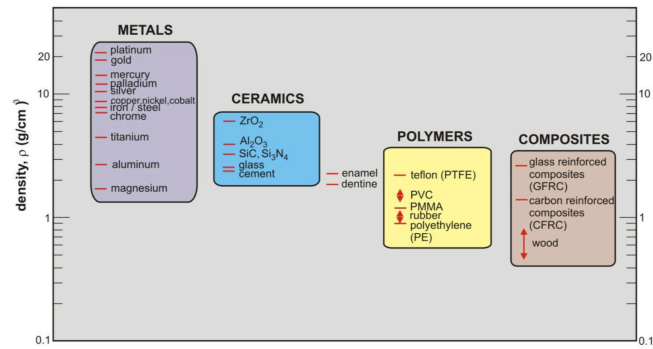
- hue
- saturation
- brightness



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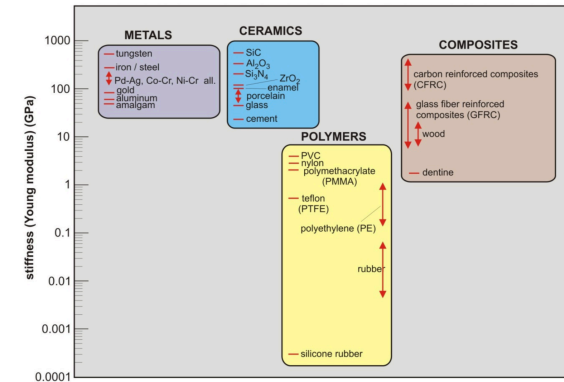
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Comparison of dental materials



Density: polymers, composites < ceramics < metals

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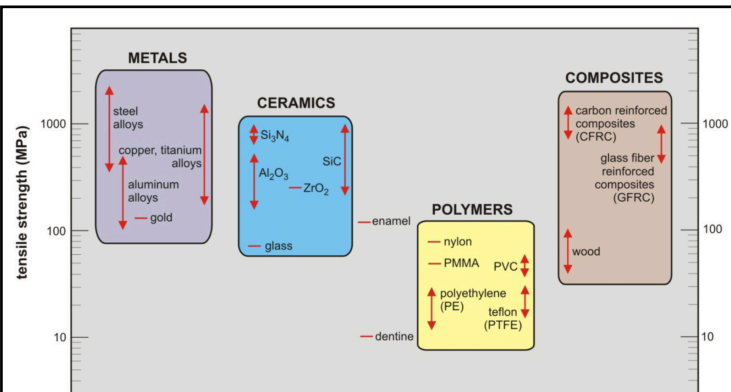


Stiffness: polymers < composites < metal, ceramics

resilience: ceramics < metals < composites < polymers

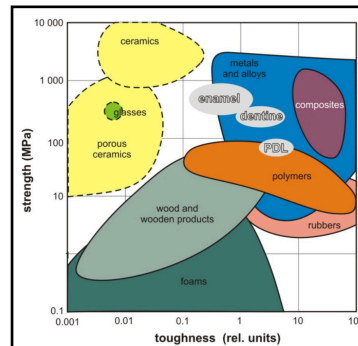
Ductility: ceramics < metals, composites, polymers

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tensile strength: polymers < composites, ceramics < metals

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compressive strength:
polymers < composites, ceramics, metals

Toughness:
ceramics < polymers, composites, metals

Hardness:
polymers < composites < metals < ceramics

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Electric conductance: ceramics, composites, polymers < metals

Thermal conductance: ceramics, composites, polymers < metals

Melting point: polymers < composites < metals < ceramics

thermal expansion coefficient: ceramics < metals < composites < polymers

Reflectance: ceramics, composites, polymers < metals

Transmittance: metals < composites < polymers, ceramics

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metals

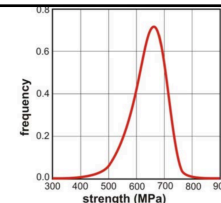
In general:

- solid
- large density
- stiff
- strong
- ductile (malleable)
- tough (ductile fracture)
- hard
- low specific heat
- good heat conduction
- good heat shock resistance
- good electric conduction
- opaque, high reflectance
- poor corrosion resistance

ceramics

In general:

- solid
- medium density
- stiff
- strong (medium tensile strength)
- not ductile
- brittle (brittle fracture)
- „crack sensitive“
- very hard
- medium specific heat
- thermal insulator
- low heat shock resistance
- electric insulator
- diverse optical properties
- good corrosion resistance



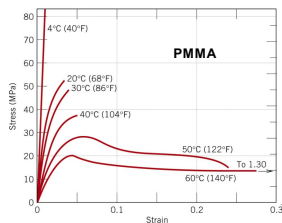
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polymers

In general:

- liquid or solid
- low density
- low stiffness - elastic
- medium or weak strength
- ductile
- medium toughness
- medium hardness - soft
- viscoelastic
- medium specific heat
- thermal insulator
- medium heat shock resistance
- electric insulator
- diverse optical properties
- medium corrosion resistance



Important:

- temperature
- molecular mass
- degree of crystallinity

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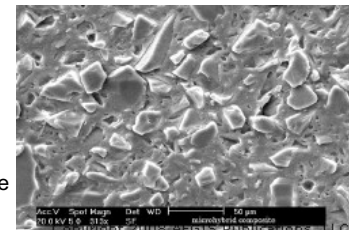
composites (dental)

In general:

- solid
- low – medium density
- medium stiffness - elastic
- strong
- ductile
- tough
- hard – medium hard
- viscoelastic
- medium specific heat
- thermal insulator
- medium heat shock resistance
- electric insulator
- diverse optical properties
- good corrosion resistance

Important:

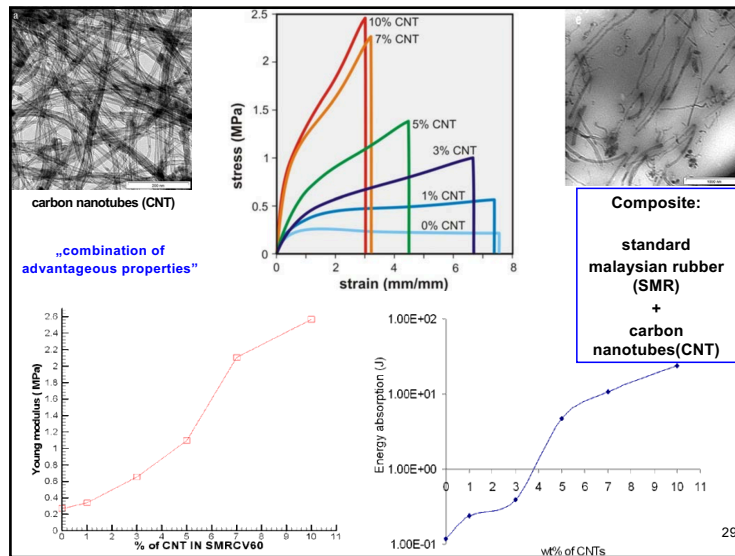
- composition
- particle size of dispersion phase



→ microhybrid → nanohybrid composites

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