



Fogorvosi anyagtan fizikai alapjai

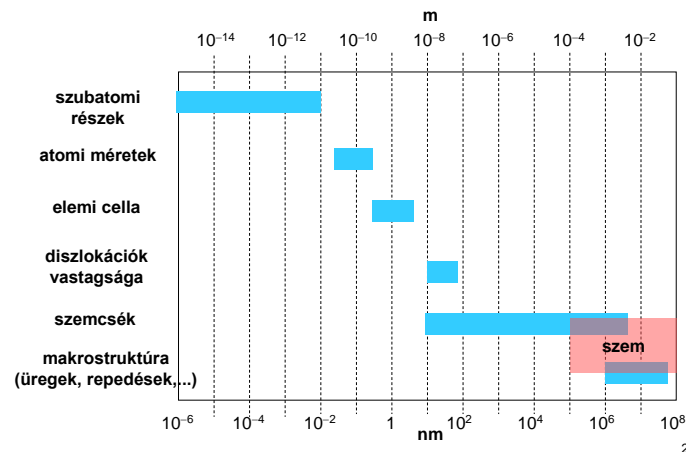
4.

Általános anyagszerkezeti ismeretek
Szerkezetvizsgálati módszerek



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Szerkezeti elemek méretei

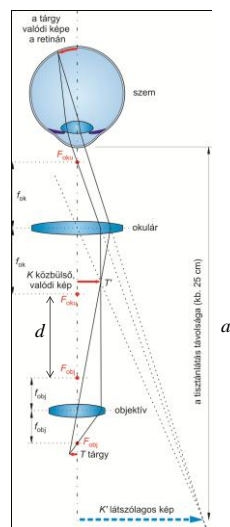


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Fénymikroszkóp

$$N = N_{obj} \cdot N_{ok} = -\frac{a \cdot d}{f_{obj} \cdot f_{ok}}$$

(< kb. 2000)



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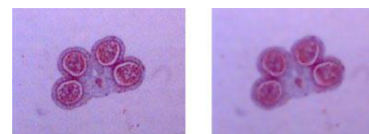
Felbontási határ (δ):

$$\delta = 0,61 \frac{\lambda}{n \cdot \sin \omega}$$

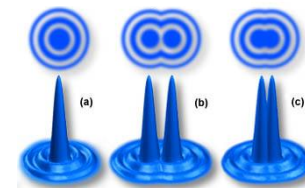
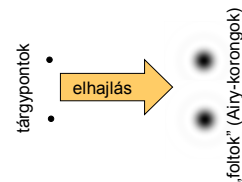
$$\delta \approx \frac{\lambda}{NA}$$

hullámhossz

numerikus apertúra (NA)



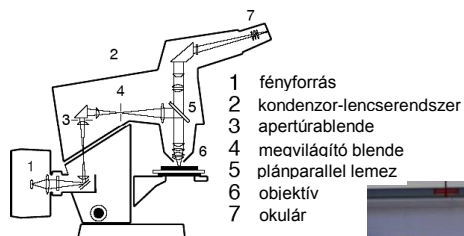
Véges felbontás oka:



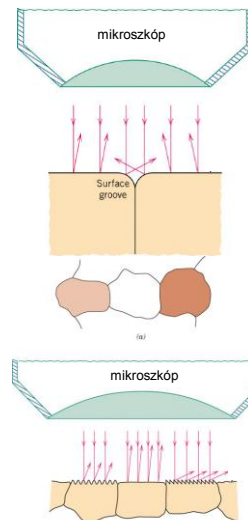
$\delta \approx 200 \text{ nm}$

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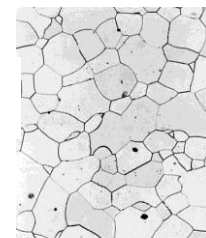
Fémmikroszkóp



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Előkészítés :
• csiszolás
• maratás



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Elektronmikroszkóp

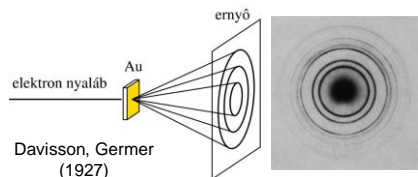
$$\delta \approx \frac{\lambda}{NA}$$

Alapja: de Broglie (1923):

$$\lambda = \frac{h}{mv}$$

Planck-állandó
($h = 6,63 \cdot 10^{-34} \text{ J/s}$)

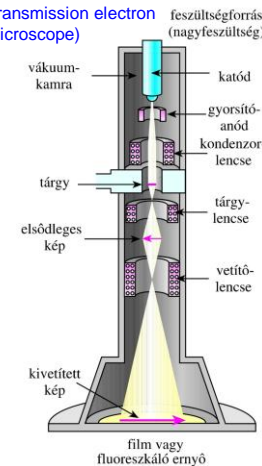
az elektron
lendülete



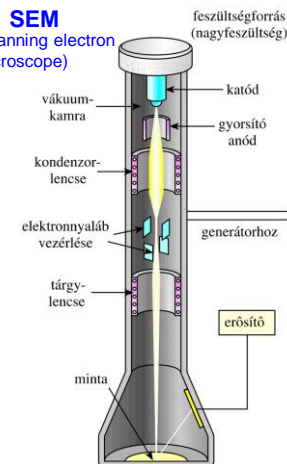
$$\left. \begin{array}{l} \lambda \approx 0,005 \text{ nm} \\ NA \approx 0,03 \end{array} \right\} \longrightarrow \delta \approx 0,2 \text{ nm}$$

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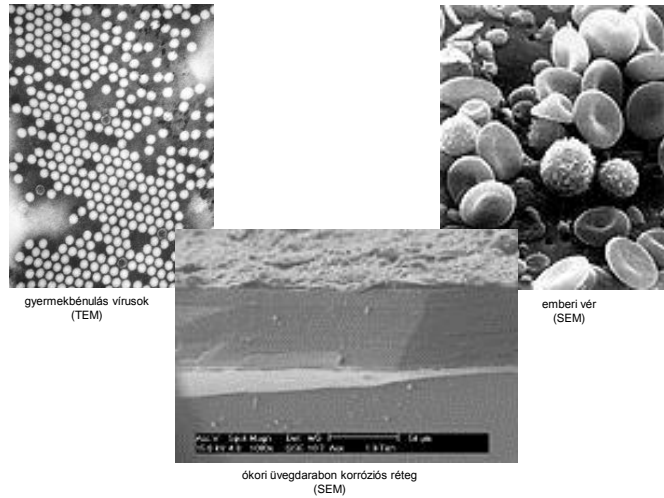
TEM (transmission electron microscope)



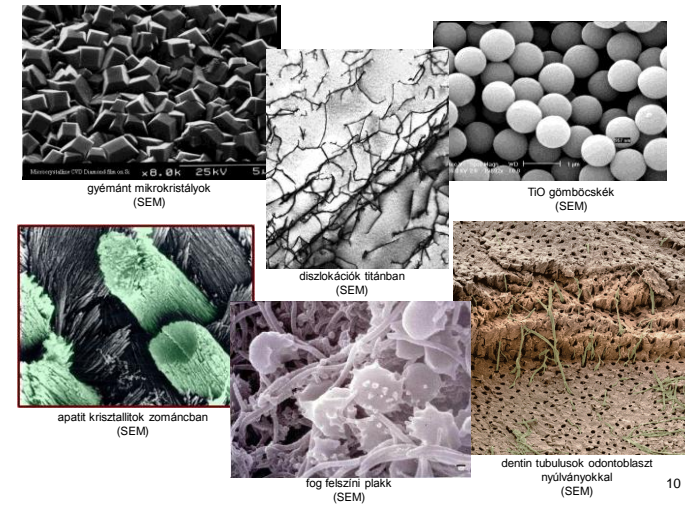
SEM (scanning electron microscope)



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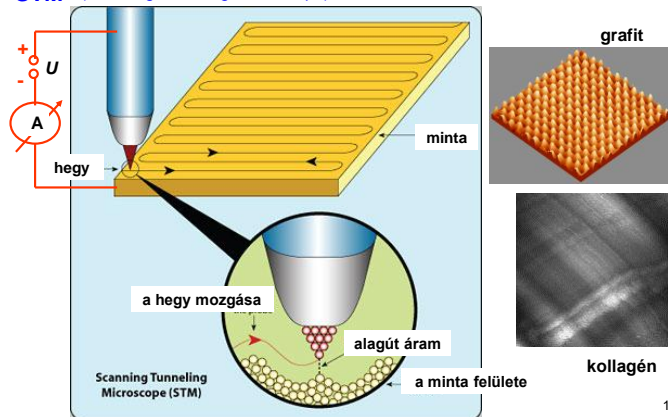
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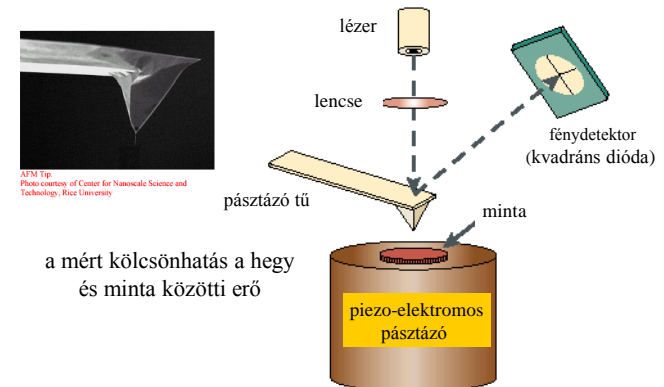
Pásztázószondás mikroszkóp (SPM)

STM (scanning tunneling microscope)



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AFM (atomic force microscope)



a mért kölcsönhatás a hegy és minta közötti erő

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Kitérő: piezoelektromosság

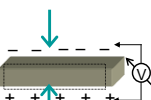
1880 P. Curie (piezein = gör összenyom)

pl.: kvarc

kvarc lapka

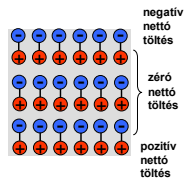
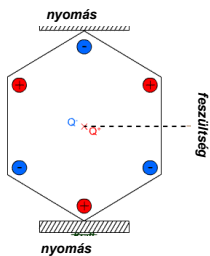


deformáció



$$U = \delta \cdot \Delta x$$

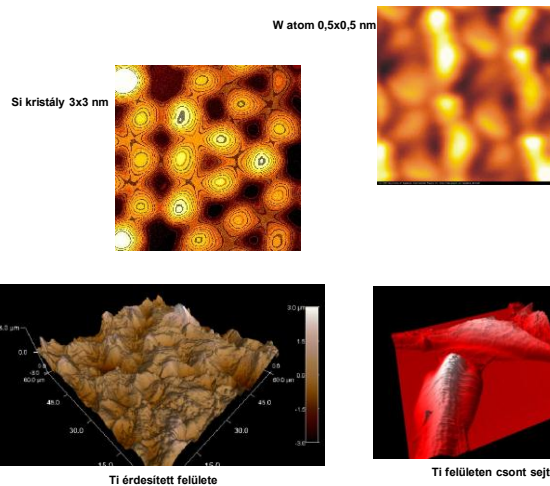
pl. kvarcnál: $\delta \approx 10^{12} \text{ V/m}$



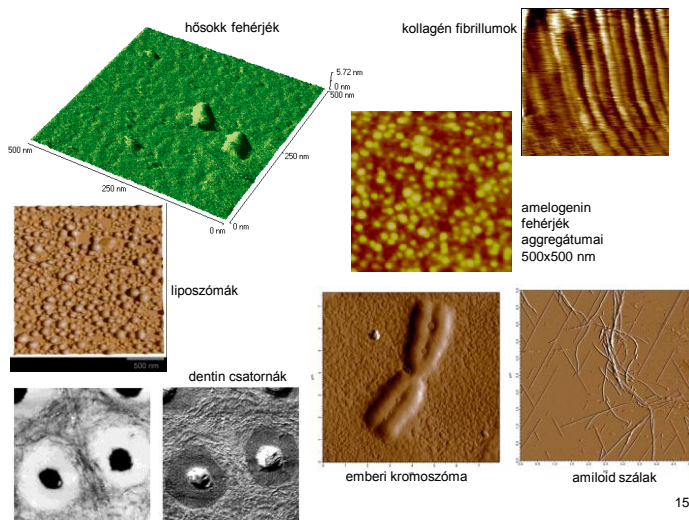
piezoelektromos hatás: deformáció \Rightarrow elektromos tér

inverz piezoelektromos hatás: elektromos tér \Rightarrow deformáció

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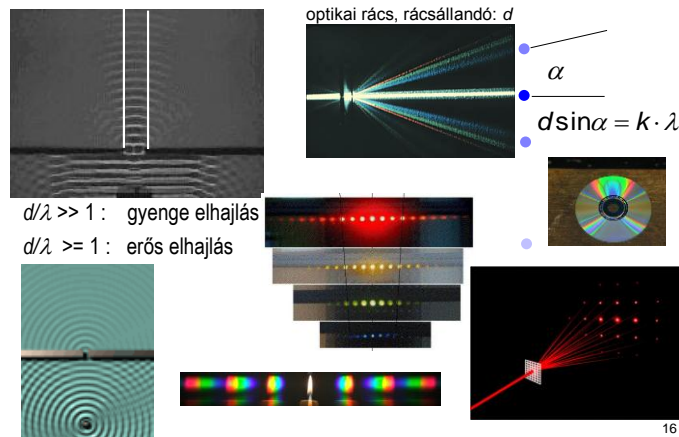


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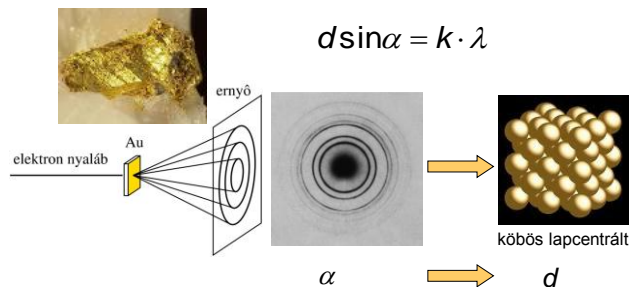
Diffrakció (elhajlás)



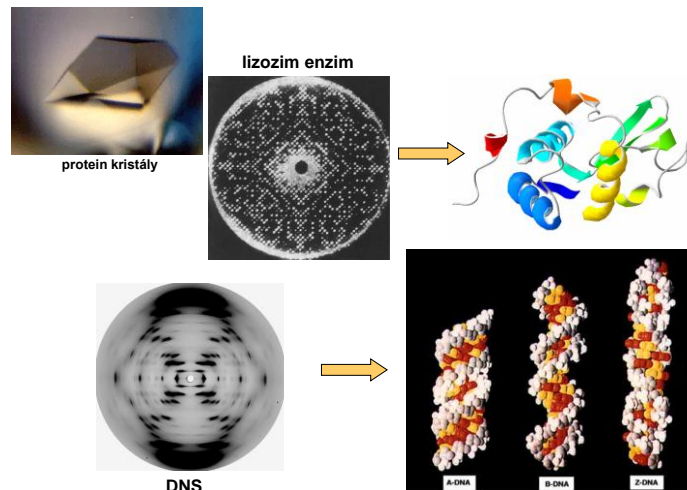
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Diffrakciós módszerek

- röntgendifrakció $\lambda \approx 0,01-0,1 \text{ nm}$
- neutrondifrakció $\approx 0,1 \text{ nm}$
- elektrondifrakció $\approx 0,01 \text{ nm}$

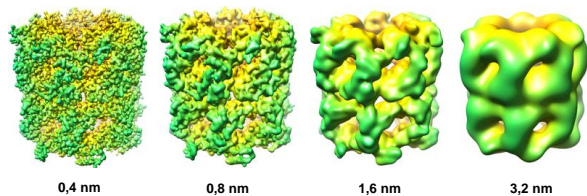


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GroEL különböző felbontással:



Hemoglobin:



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