

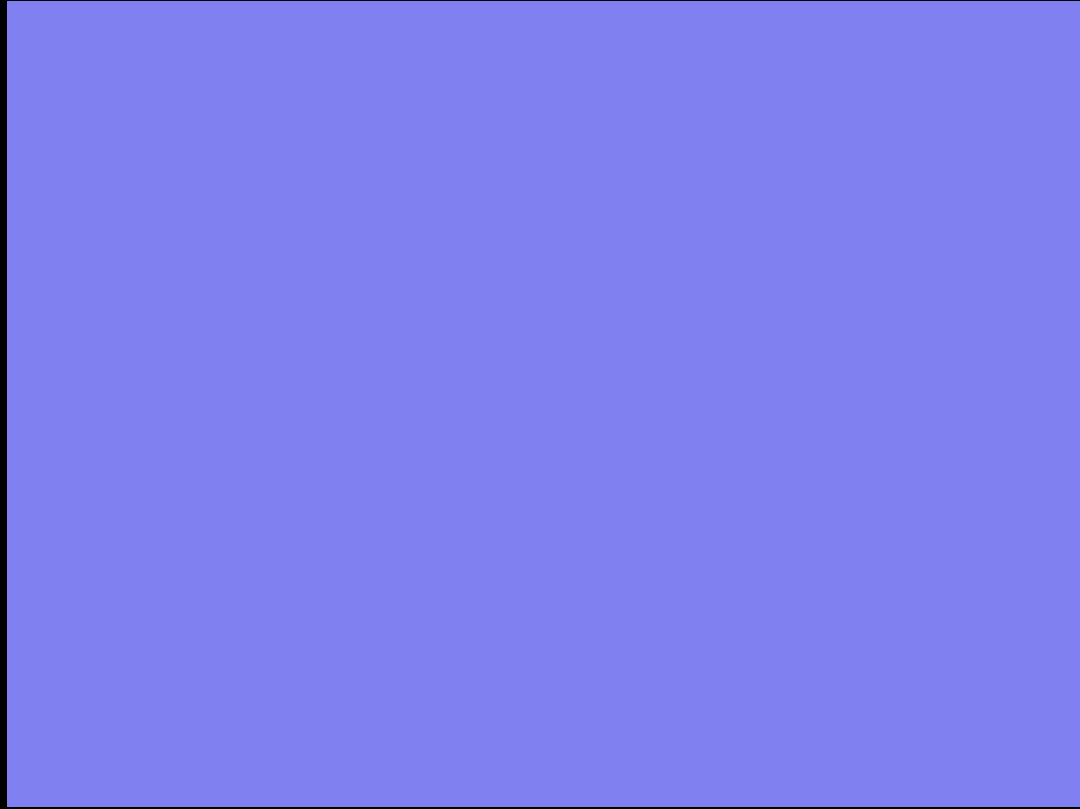
CSODÁLATOS ANYAGOK

Lendvai János

Anyagtudományi Tanszék

<http://metal.elte.hu>



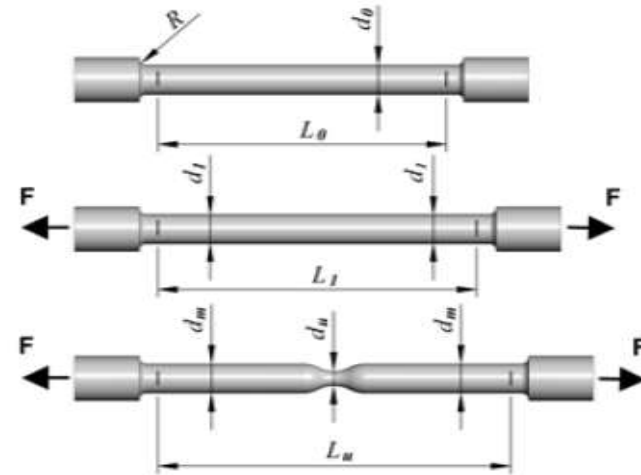
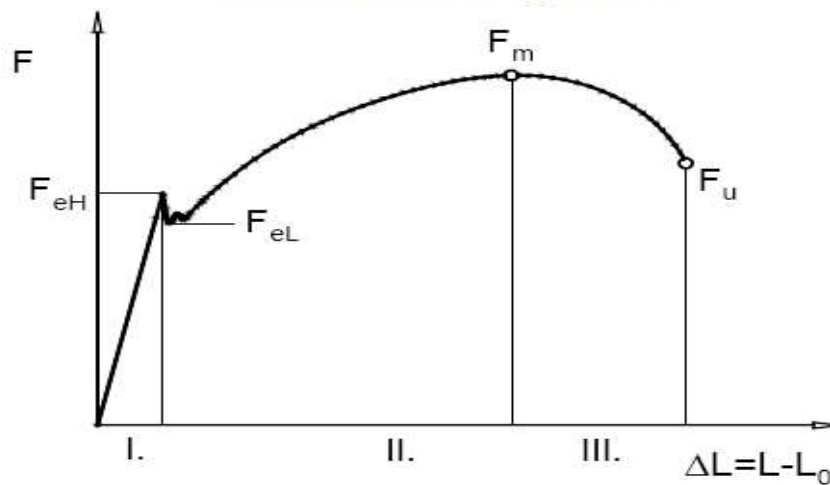




Kristályos anyagok alakváltozása

Szakítóvizsgálat

Szakítódiagram

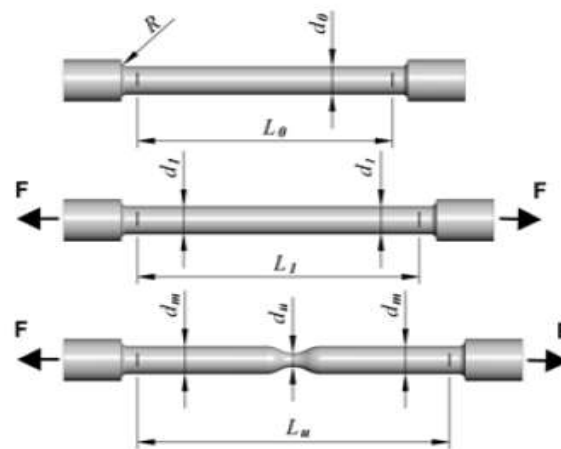
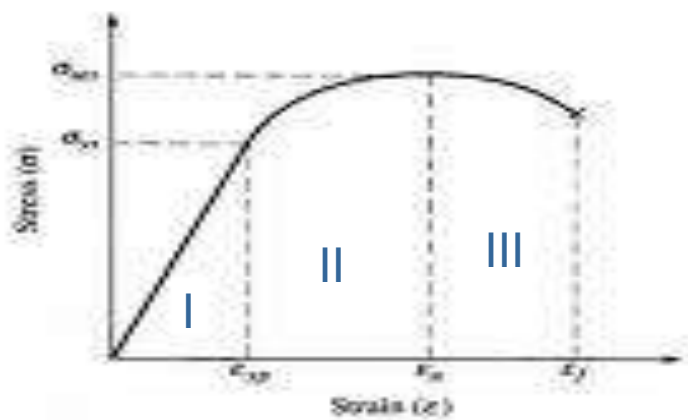


- I. Rugalmas alakváltozás
- II. Egyenletes képlékeny alakváltozás
- III. Kontrakció

Kristályos anyagok alakváltozása

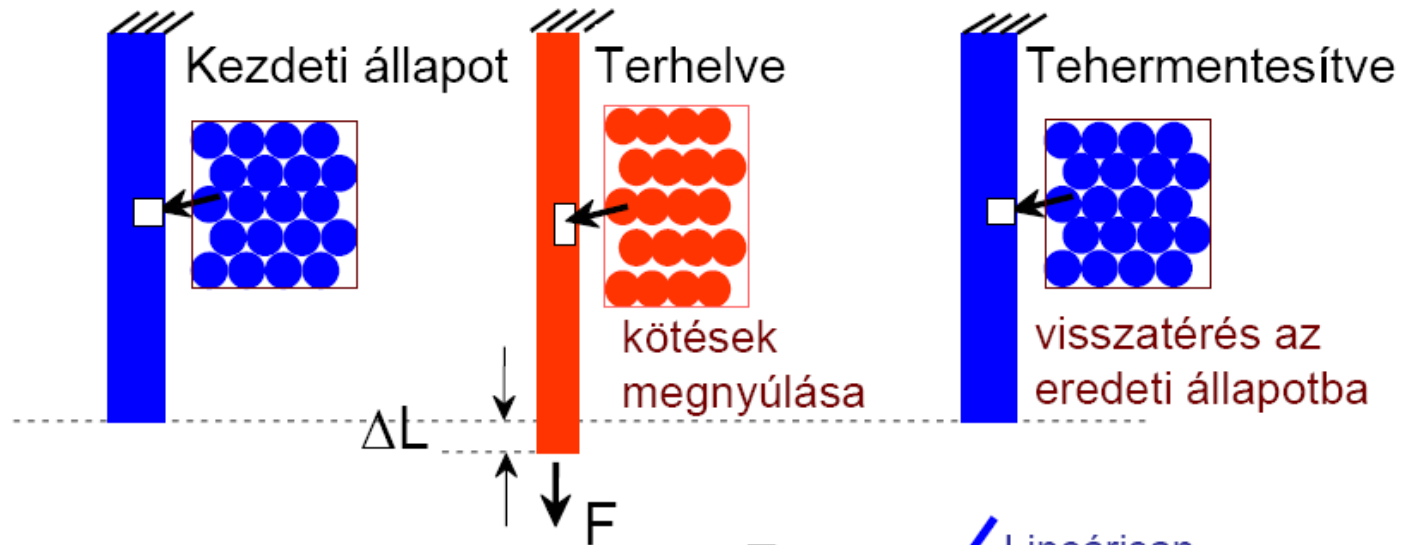
Szakítóvizsgálat

Szakítódiagram



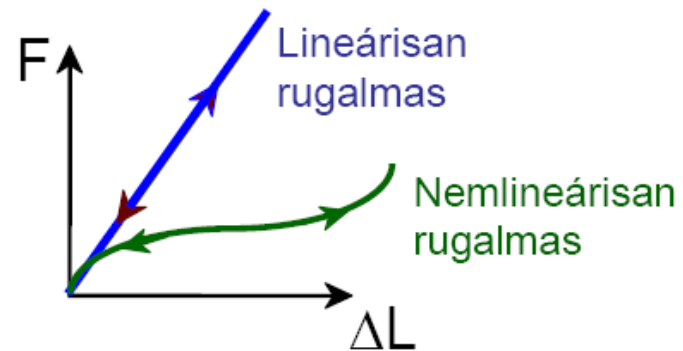
- I. Rugalmas alakváltozás
- II. Egyenletes képlékeny alakváltozás
- III. Kontrakció

Rugalmas alakváltozás

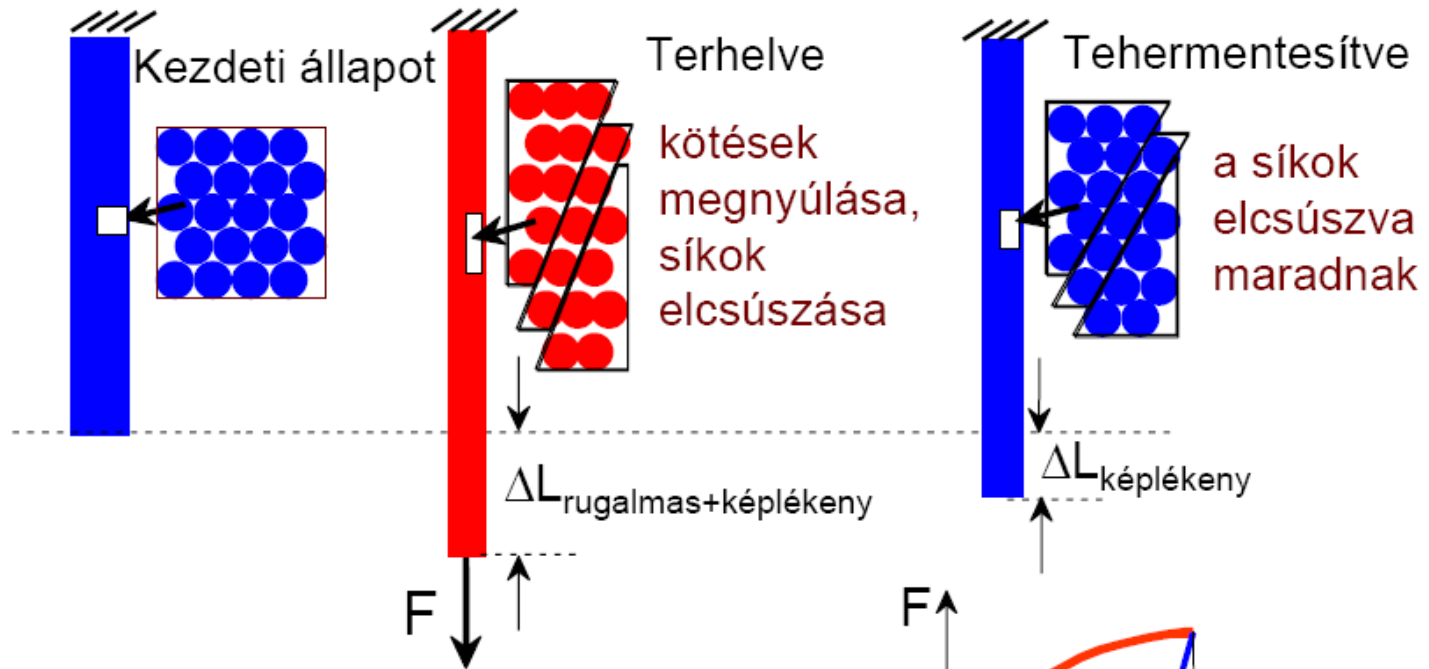


Rugalmas = reverzibilis

Rugalmas alakváltozásnál
a térfogat nem állandó.

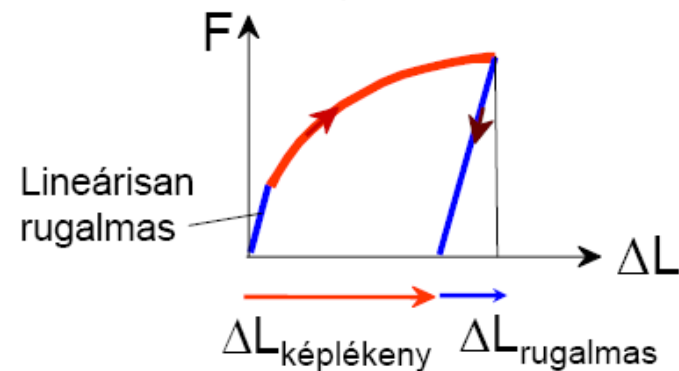


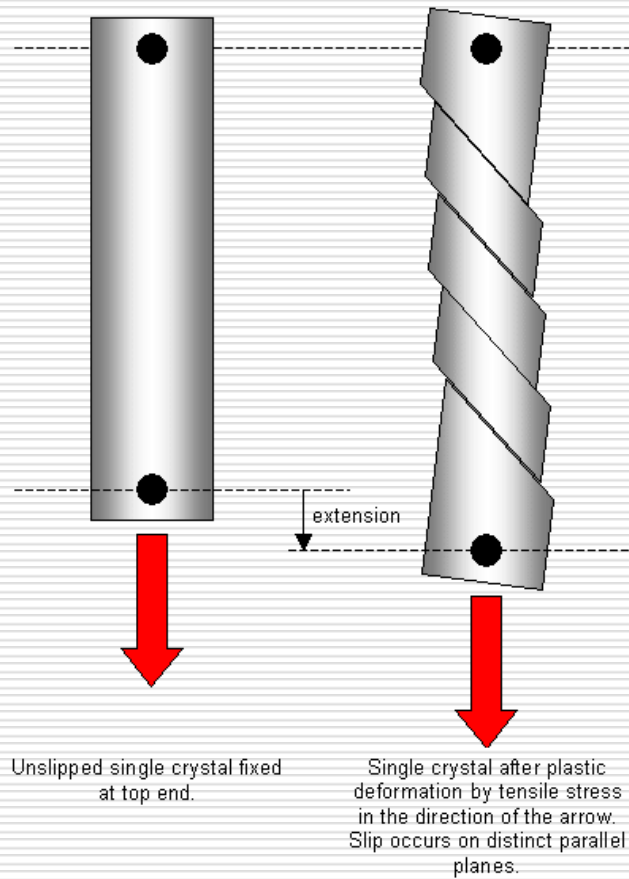
Képlékeny alakváltozás



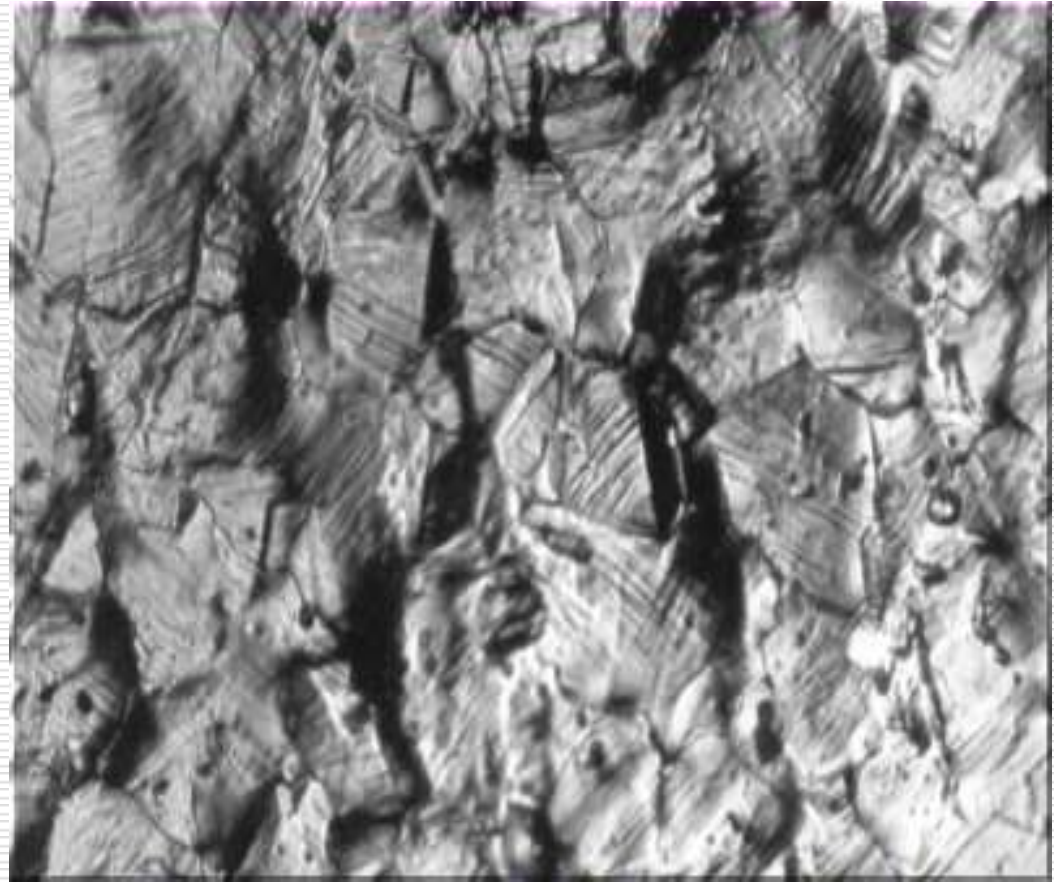
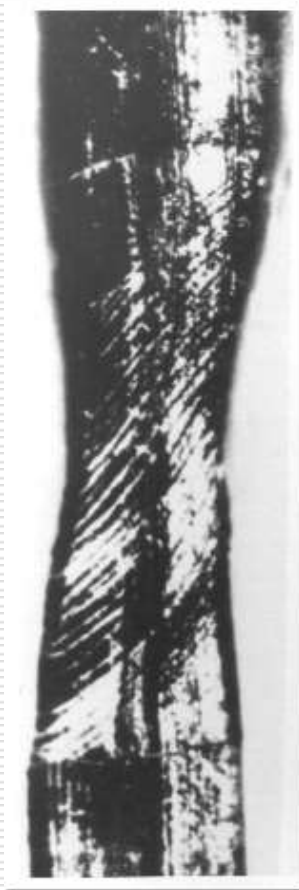
Képlékeny = **maradó**

Képlékeny alakváltozásnál a térfogat állandó.



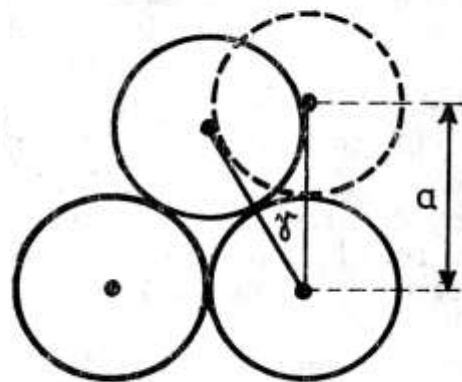
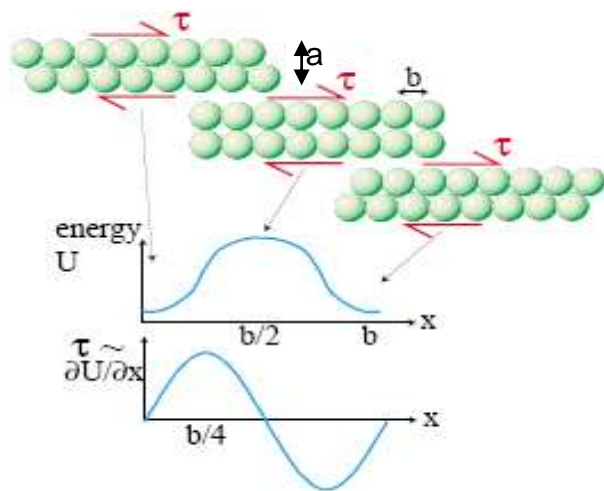


Képlékeny alakváltozás



Minden maradó deformáció alapja a NYÍRÁS

A folyáshatár becslése



$$\tau = \tau_0 \cdot \sin \frac{2\pi}{b} x$$

$$x \ll b$$

$$\tau \approx \tau_0 \frac{2\pi}{b} x$$

$$\tau = G \cdot \gamma$$

$$\gamma \approx \text{tg} \gamma = \frac{x}{a}$$

$$\tau_0 \frac{2\pi}{b} x = G \frac{x}{a}$$

$$\tau_0 \approx \frac{G}{2\pi}$$

Diszlokációk felfedezése: 1934

Orován Egon



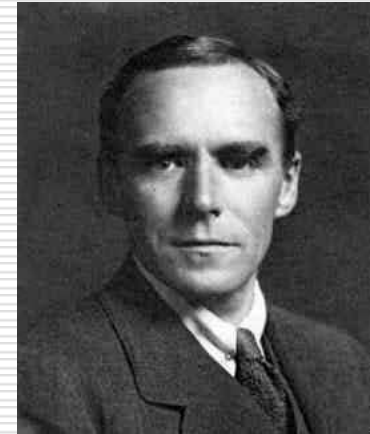
1902-1989

Polányi Mihály



1891-1976

Geoffrey I. Taylor



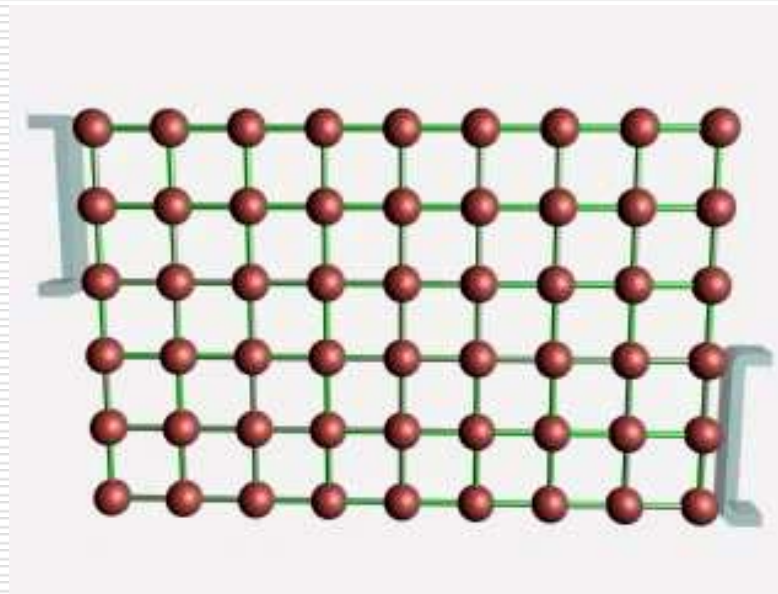
1886-1975

Megoldás: a csúszás fokozatosan történik

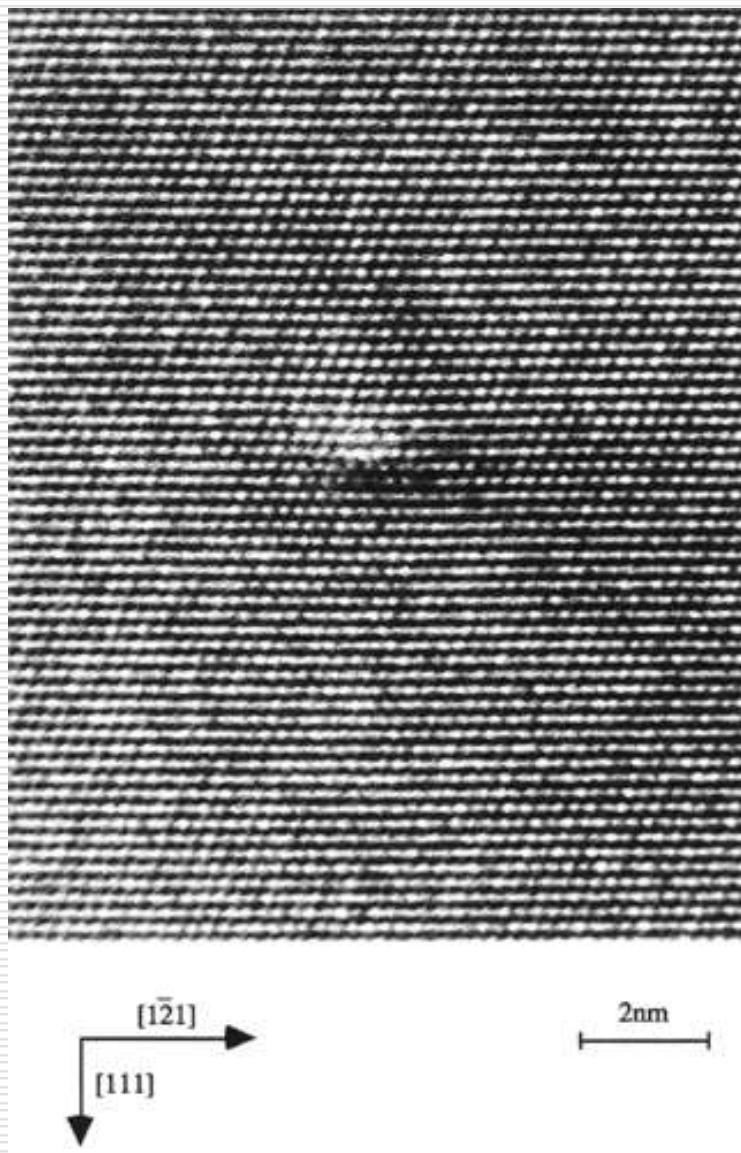
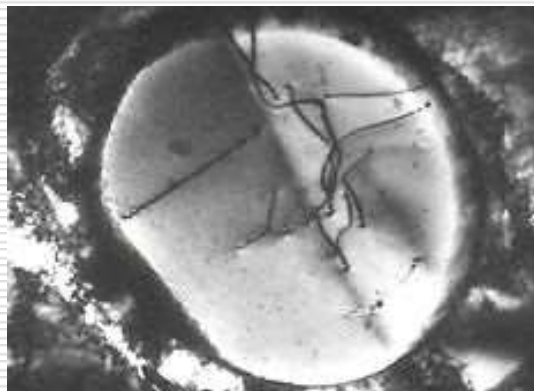
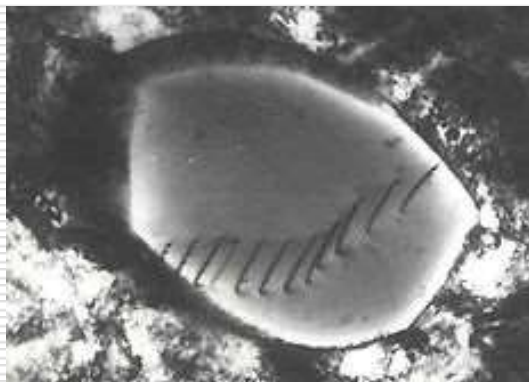
Orován

Polányi 1934

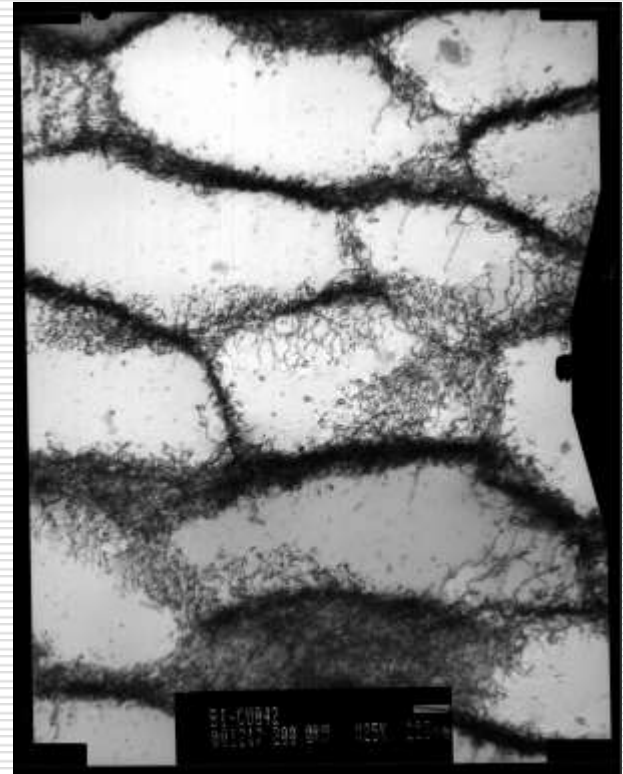
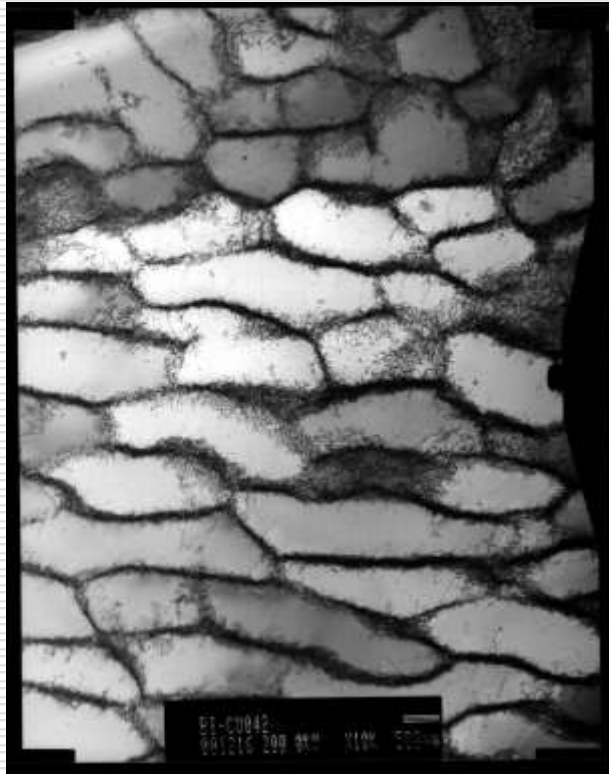
Taylor



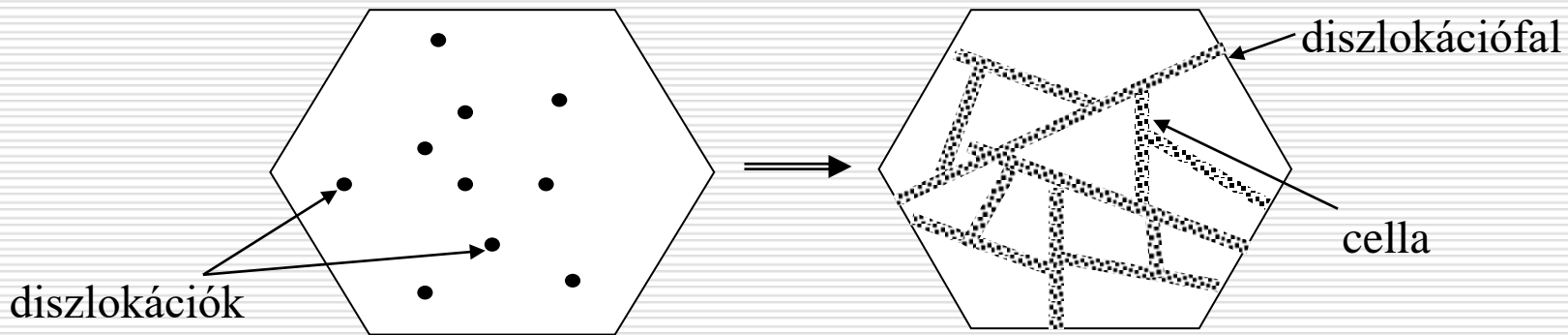
TEM képek diszlokációkról:



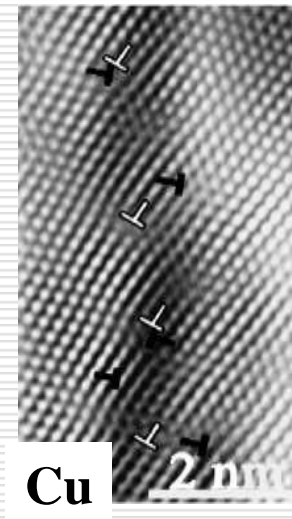
Diszlokációszerkezet erősen deformált rézben:



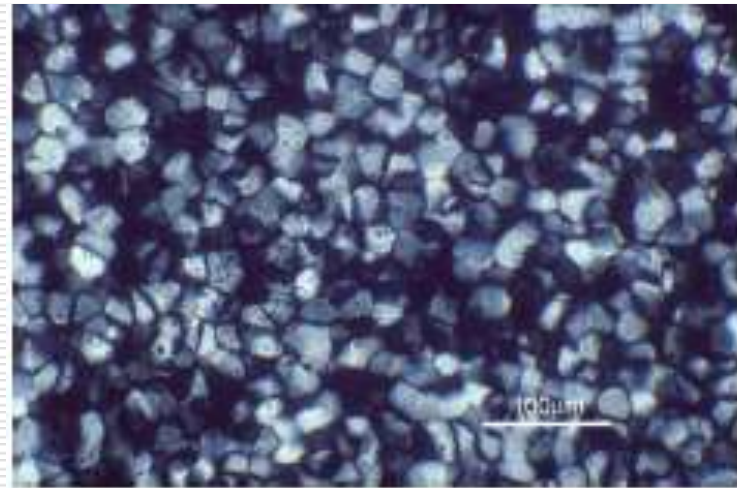
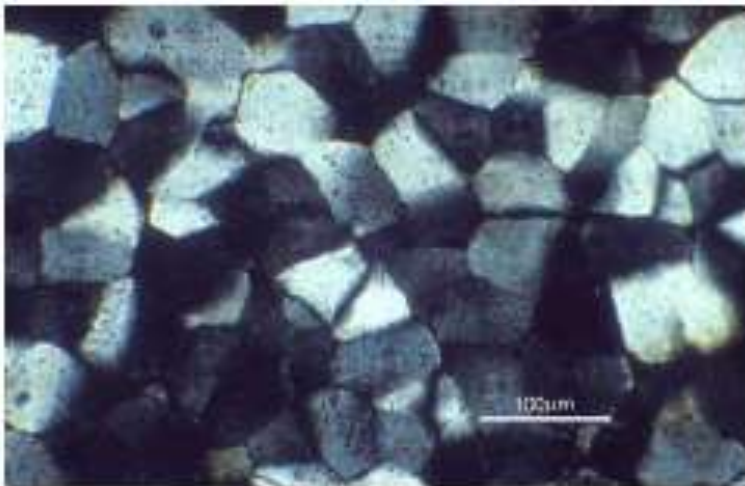
Tömbi nanokristályos anyagok előállítása szemcsefinomítással



- szemcseméret: 200-500 nm
(cellaméret: 50-100 nm)
- textúra
- kisebb termikus stabilitás



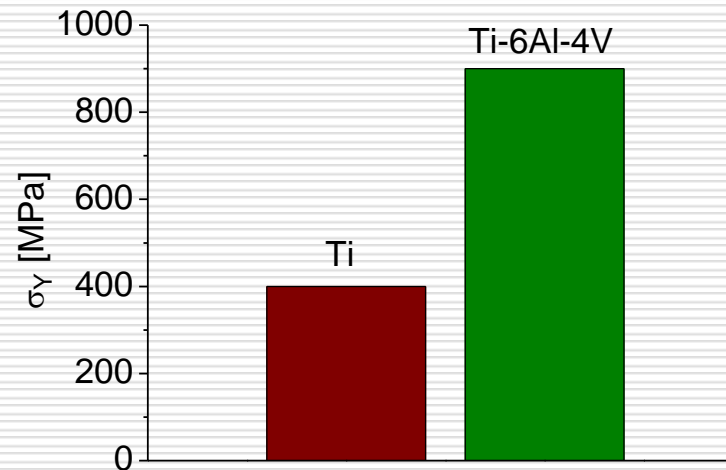
Deformáció szemcseméret- csökkenést eredményezhet:



Nanoszerkezetű titán alkalmazása sebészeti implantátumokban

A titán szövetbarát: sebészeti implantátumok alapanyaga.

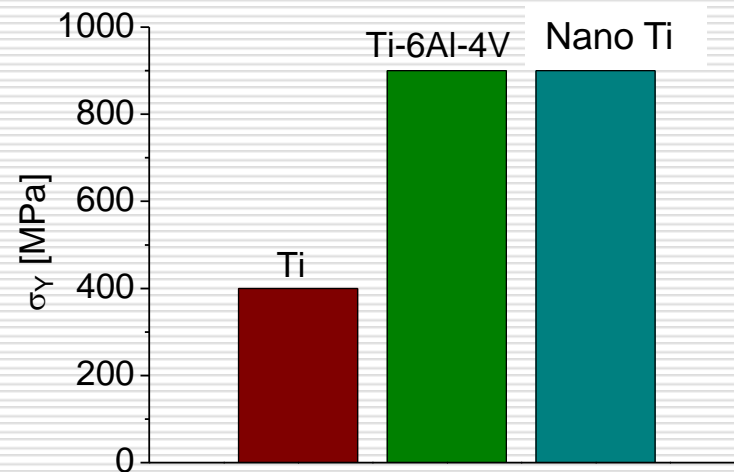
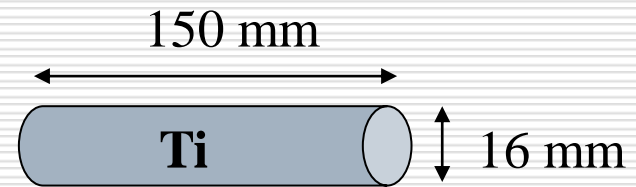
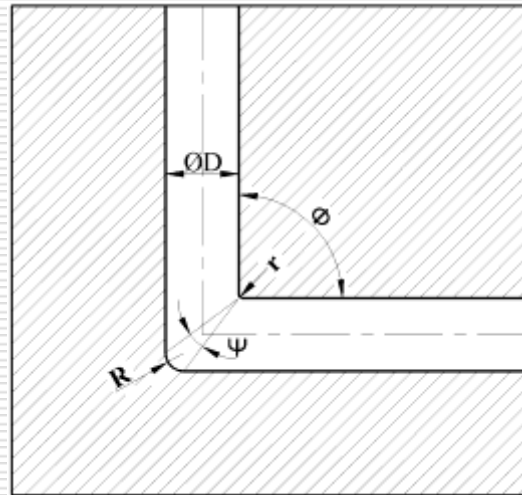
Korábban használt implantátum: *Ti-6Al-4V*



Az implantátumból a *V* beoldódik a szövetekbe: *mérgező*.

Cél: *Ti* implantátumok folyáshatárának növelése toxikus szennyezők nélkül!

8 ECAP
450 °C



Nanotitan csavar és lemez válltörések kezelésére



Országos Baleseti és Sürgősségi Intézet



Alakemlékező fémek

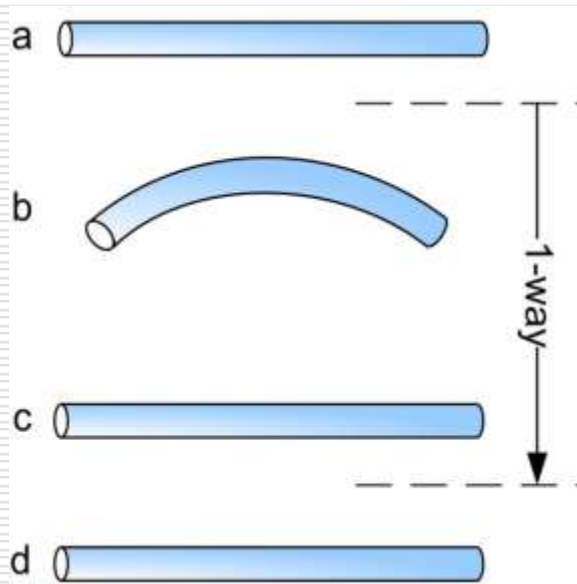




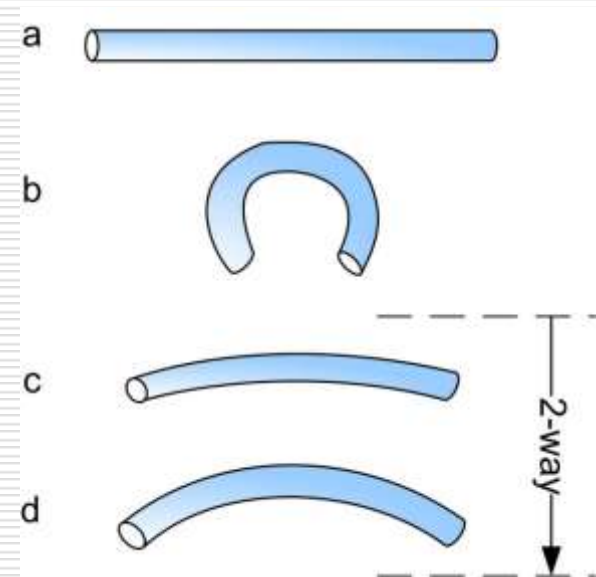
Alakemlékező fémek

(Shape Memory Alloys, SMA
Smart Materials)

Egy irányban:

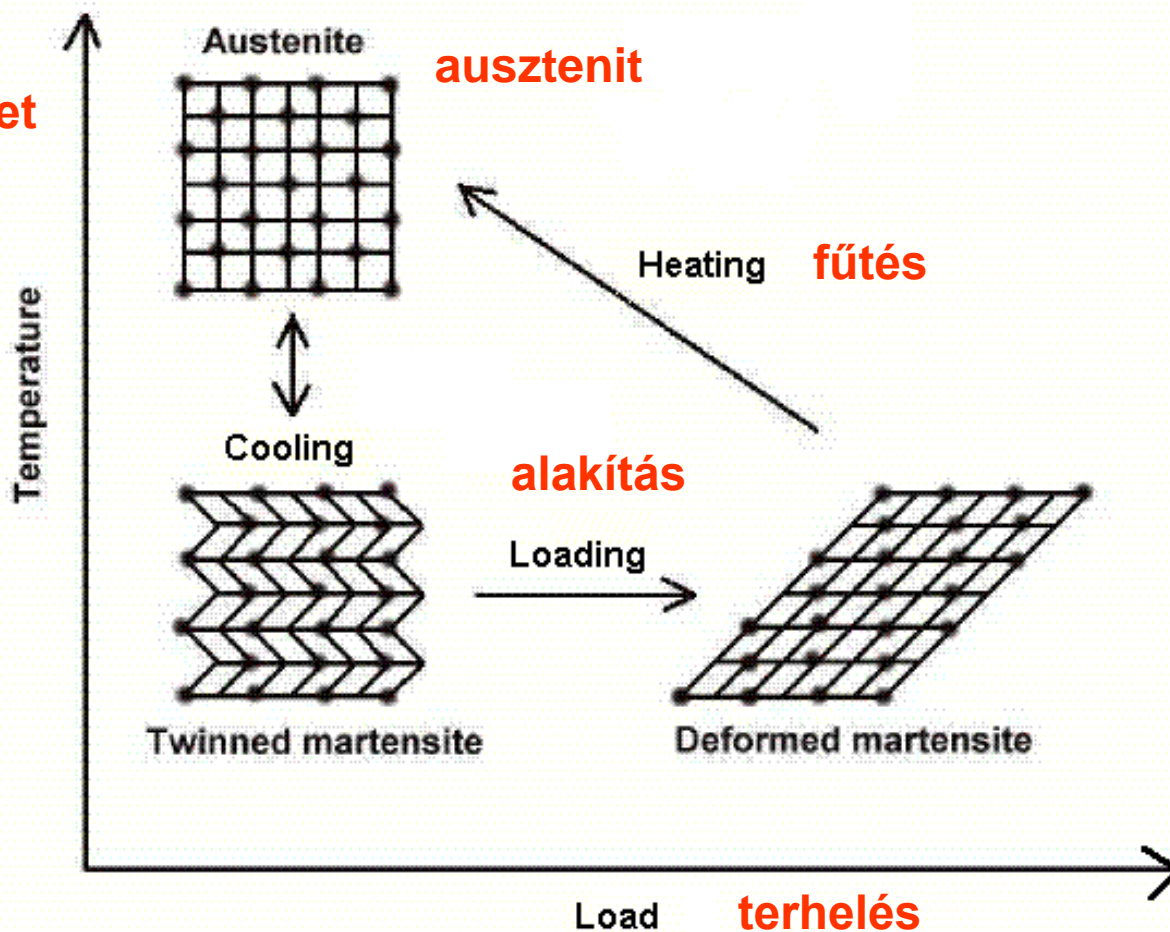


Oda-vissza:



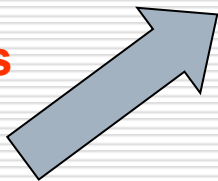
Alakemlékezés mechanizmusa:

hőmérséklet

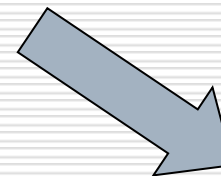




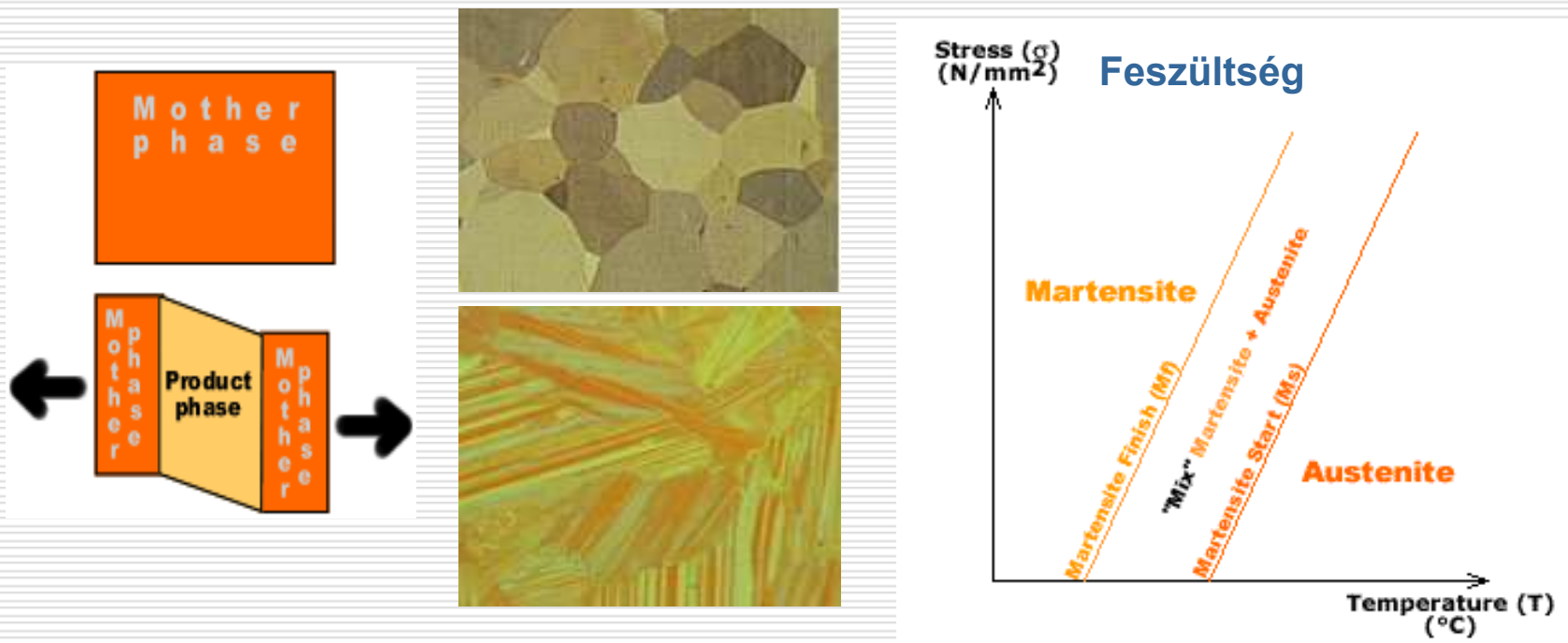
melegítés



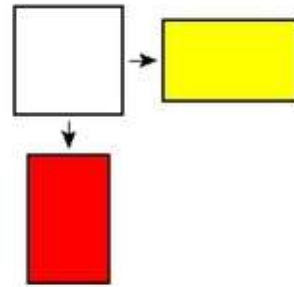
hűtés



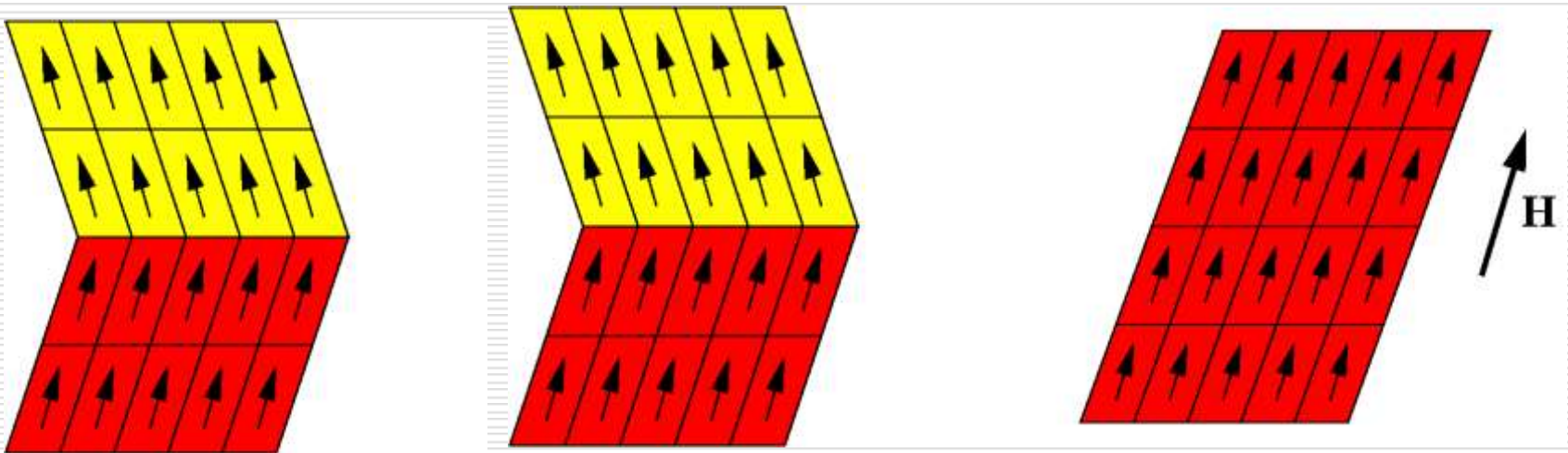
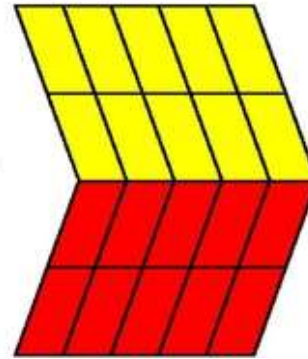
Martenzites szerkezet kialakulása



Martensitic transformation

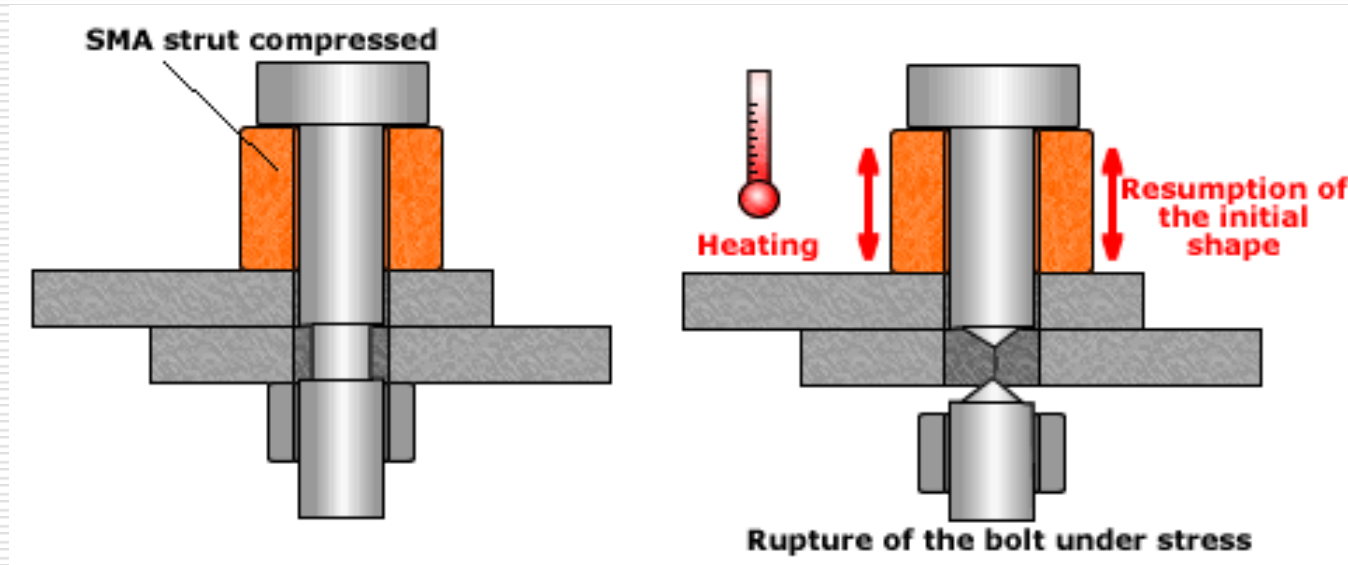


Twinned microstructure

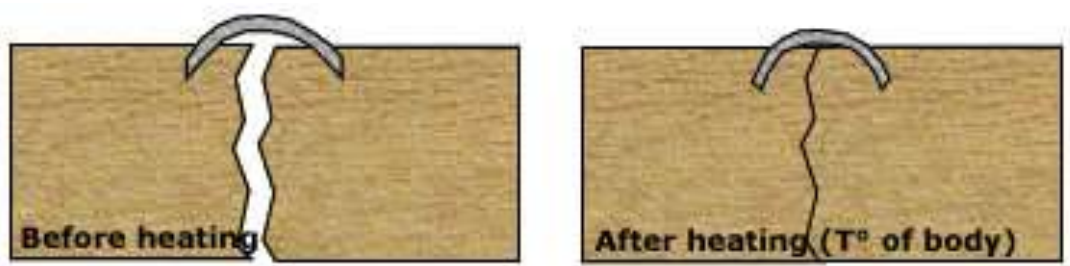


[Helsinki University of Technology,
Laboratory of Physics]

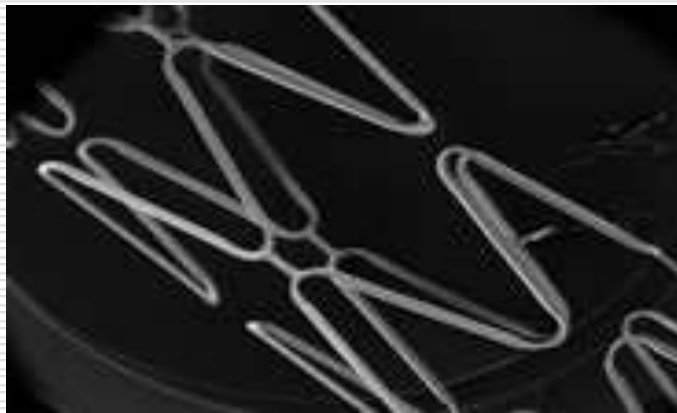
Űrtechnikai alkalmazások:



Orvosi alkalmazások:



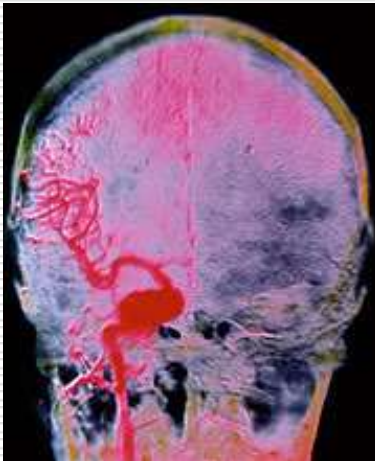
Rögzítő kapcsok csonttöréseknél



Értágító sztentek

A „stroke” kezelése TiNi „dugóhúzó”-val.

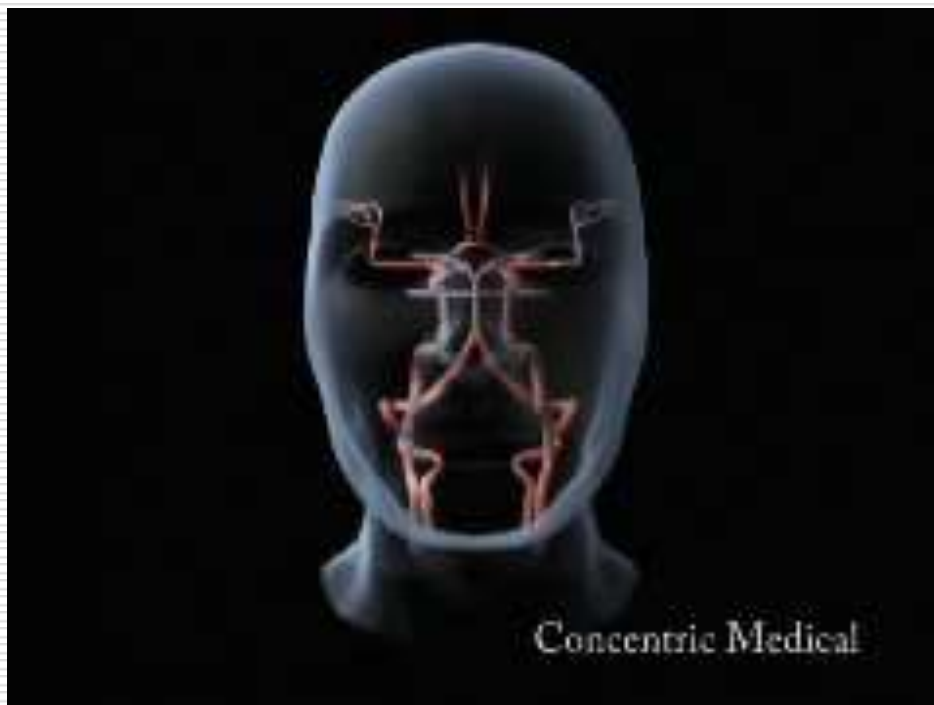
Stroke



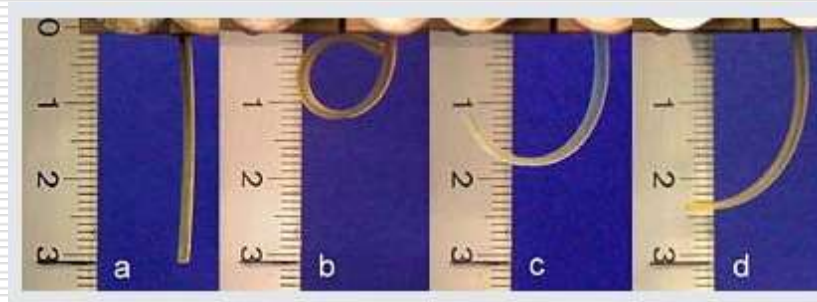
TiNi „dugóhúzó”



University of California at LA

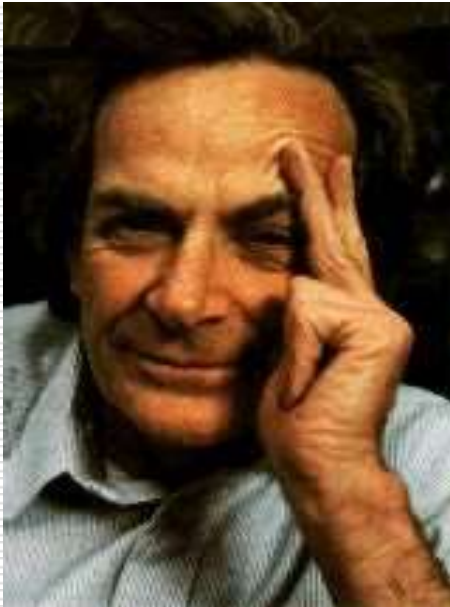


Alakmélkező műanyagok:



Spagettitörés rejtélye:

Richard Feynman
(1918-1988)
(Nobel-díj 1965)



Daniel W. Hillis



Pierre-Gilles de Gennes

(Nobel-díj 1991)



Fragmentation of Rods by Cascading Cracks: Why Spaghetti Does Not Break in Half

Basile Audoly and Sébastien Neukirch

Laboratoire de Modélisation en Mécanique, CNRS/Université Paris VI, 4 place Jussieu, Paris, France

(Received 22 December 2004; published 25 August 2005)

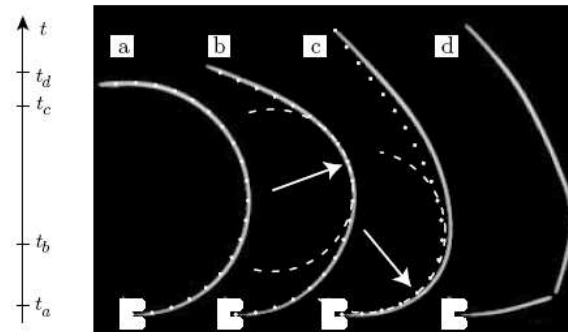


FIG. 3. A dry spaghetti is bent into an arc of circle and suddenly set free, while its lower end remains clamped. Its subsequent dynamics exhibits a local increase of curvature. Selected frames shot with a fast camera at 1000 Hz: (a) release $t_a = 0$, (b) intermediate frame $t_b = 0.0159T$, (c) frame just before rupture $t_c = 0.0509T$, and (d) frame after rupture $t_d = 0.0596T$. Predictions of the self-similar and numerical simulations based on Eq. (1) are superimposed, without any adjustable parameters: rod profile (dotted line) and osculating circle (dashed lines) at the point of largest curvature (arrow). Note that the rod breaks at the point of maximal curvature.

Dynamic Buckling and Fragmentation in Brittle Rods

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¹*W. G. Pritchard Laboratories, Department of Mathematics, Penn State University, University Park, Pennsylvania 1*

²*Institut de Recherche sur les Phénomènes Hors Equilibre, Université de Provence 49, rue Frédéric Joliot-Curie 133*

Cedex 13, France

(Received 21 October 2004; published 25 January 2005)

We present experiments on the dynamic buckling and fragmentation of slender rods axially impacted by a projectile. By combining the results of Saint-Venant and elastic beam theory, we derive a preferred wavelength λ for the buckling instability, and experimentally verify the resulting scaling law for a range of materials including teflon, dry pasta, glass, and steel. For brittle materials, buckling leads to the fragmentation of the rod. Measured fragment length distributions show two peaks near $\lambda/2$ and $\lambda/4$. The nonmonotonic nature of the distributions reflect the influence of the deterministic buckling process on the more random fragmentation processes.

DOI: 10.1103/PhysRevLett.94.035503

PACS numbers: 62.20.Mk, 46.32.+z, 46.40.Ft, 46.50.+a

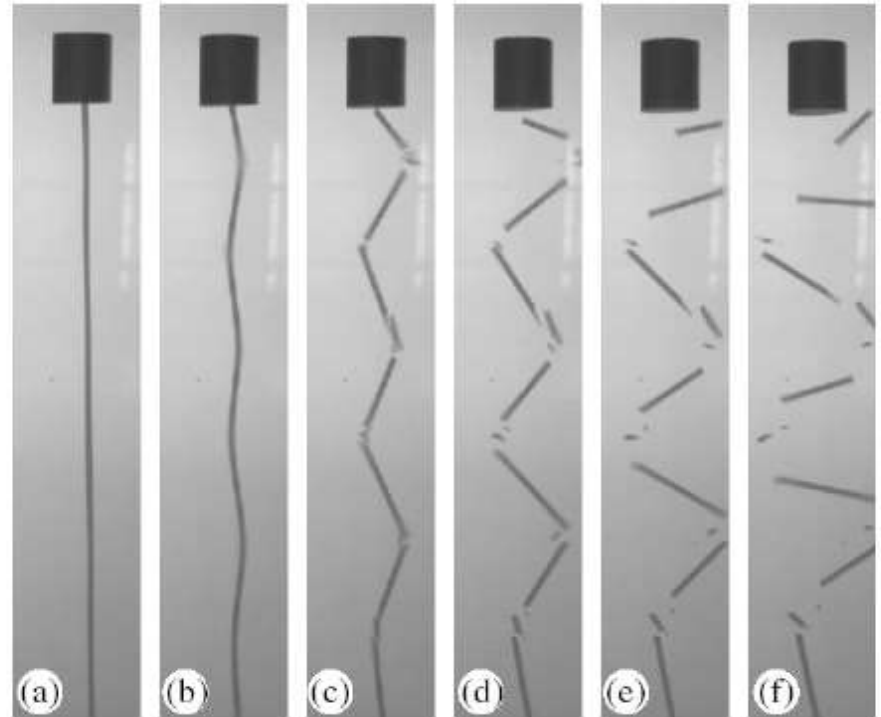


FIG. 1. The dynamic buckling and fragmentation of dry pasta ($d = 1.9$ mm, $L = 24$ cm) just after the impact of an aluminum projectile at velocity $U_0 = 3.5$ m/s (interval between pictures: $236 \mu\text{s}$).

Fragmentation of Shells

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¹*Institute of Statics and Dynamics of Aerospace Structures, University of Stuttgart, Pfaffenwaldring 27, 70569 Stuttgart, Germany*

²*Department of Theoretical Physics, University of Debrecen, P.O. Box:5, H-4010 Debrecen, Hungary*

³*ICA 1, University of Stuttgart, Pfaffenwaldring 27, D-70569 Stuttgart, Germany*

(Received 17 February 2004; published 16 July 2004)

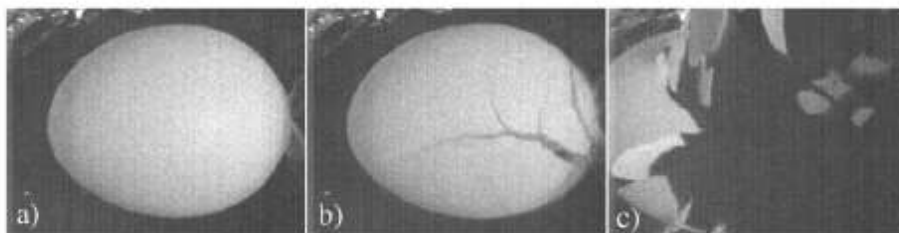


FIG. 1. Time evolution of the explosion of an egg shell. (a) Ignition, (b) instant of explosion, (c) final state.

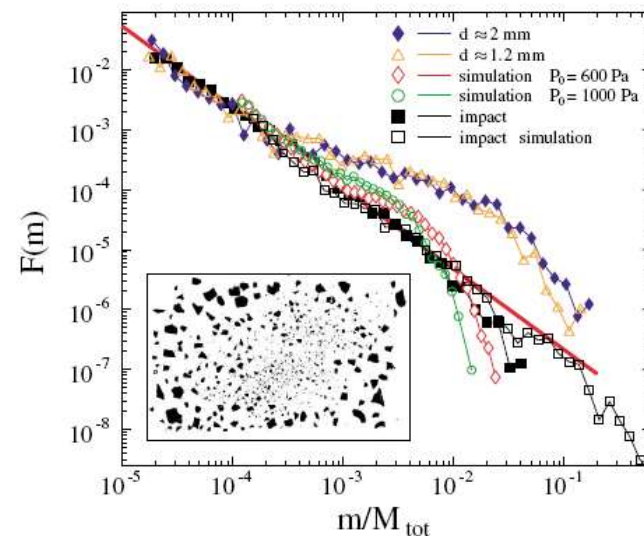


FIG. 2 (color online). Comparison of fragment mass distributions obtained in explosion experiments with two hole sizes and in the impact experiment to the simulation results. Inset: scanned pieces of an impact experiment.