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3.22 Mechanical Properties of Materials  
Spring 2008

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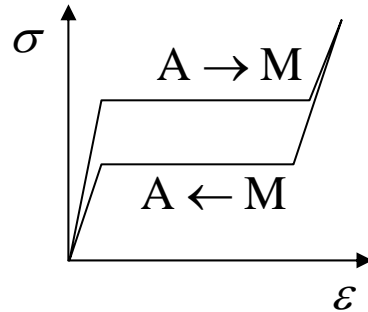
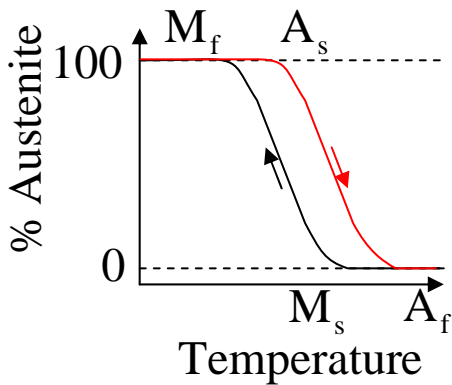
# Superelastic Materials: Shape Memory Alloys

Image removed due to copyright restrictions. Please see  
[http://www.meko.de/bilder/meko\\_niti\\_rem\\_12x\\_300.jpg](http://www.meko.de/bilder/meko_niti_rem_12x_300.jpg)

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Photo from [http://www.meko.de/stents/meko\\_home\\_highend\\_main.htm](http://www.meko.de/stents/meko_home_highend_main.htm) accessed May 5, 2008

# Phenomenology and Applications



**Temperature and electrical actuators**

Please see Fig. 4 in [1] and any photo of an SMA actuator.

[http://www.meko.de/stents/meko\\_home\\_highend\\_main.htm](http://www.meko.de/stents/meko_home_highend_main.htm)

**Eye glasses  
Piano wire  
Damper**

Please see Fig. 7 in [1] and  
<http://tbn0.google.com/images?q=tbn:hWpc6X7GZNRcnM>  
<http://lib.store.yahoo.net/lib/mbstores-store/flexon2>

<http://mbstores.com/nireiipofls.html>

**Couplings  
Fasteners**

Please see Fig. 5 in [1] and  
[http://www.vniief.ru/netcat\\_files/Image/3\(31\).jpg](http://www.vniief.ru/netcat_files/Image/3(31).jpg)

<http://en.vniief.ru/activity/Civil/Technologies/materials/>

**Stents**

Please see Fig. 6 in [1] and  
[http://www.meko.de/bilder/meko\\_niti\\_rem\\_12x\\_300.jpg](http://www.meko.de/bilder/meko_niti_rem_12x_300.jpg)

**Materials:**

- NiTi
- Cu-based
- Cu-Al-Ni
- Fe-Mn-Si
- NiTi-Zr
- Cu-Zr
- Ni-Al

Please see Fig. 3 in [1]

# Microscopic Mechanism

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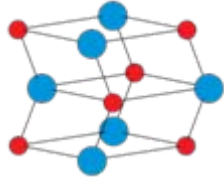
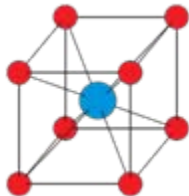


Image removed due to copyright restrictions. Please see Fig. 2-2 in [2].

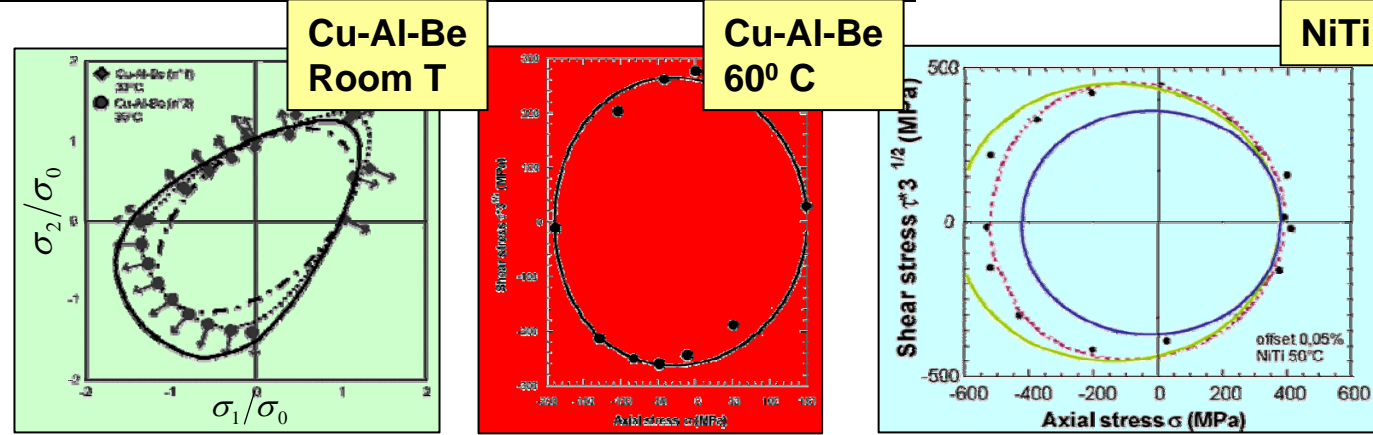


Cubic Crystal Structure

Monoclinic Crystal Structures

# Characterization for Prediction by FEA

Courtesy Elsevier, Inc.,  
<http://www.sciencedirect.com>.  
 Used with permission. [3]

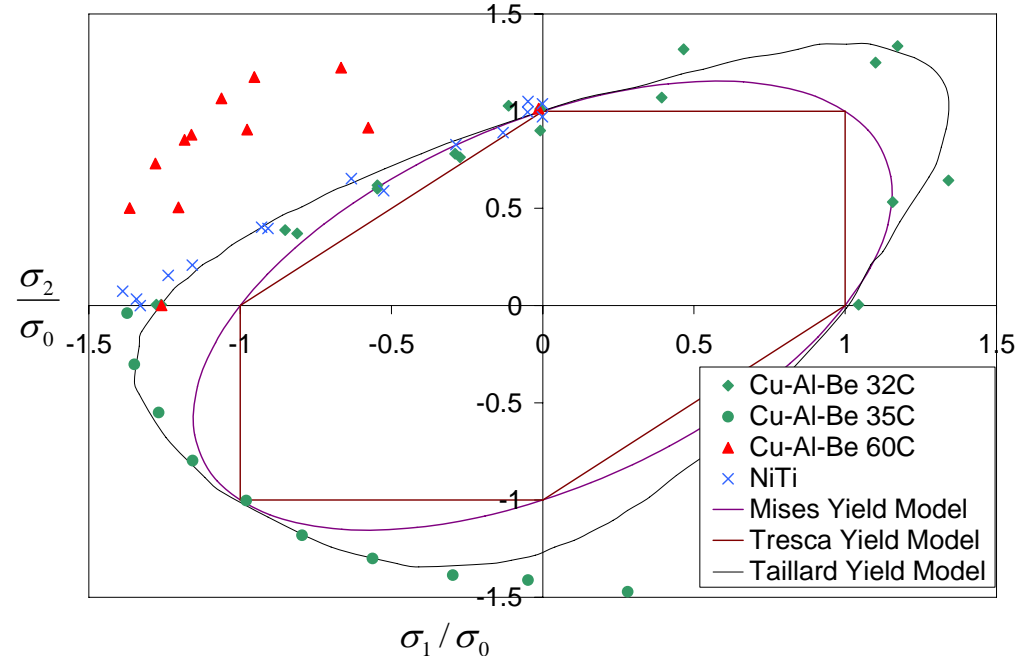


$$\sigma_{eq}^{iso} = \bar{\sigma} \times g$$

$$g \equiv \cos \left[ \frac{1}{3} \cos^{-1} (1 - a(1 - y_\sigma)) \right]$$

$$y_\sigma \equiv \frac{27 \det(\underline{\underline{\sigma}}_D)}{2 \bar{\sigma}^3}$$

$$\bar{\sigma} \equiv \left[ \frac{1}{2} \left( (\sigma_{11} - \sigma_{22})^2 + (\sigma_{22} - \sigma_{33})^2 + (\sigma_{11} - \sigma_{33})^2 \right) + 3(\sigma_{23}^2 + \sigma_{31}^2 + \sigma_{12}^2) \right]^{1/2}$$



[3] Taillard, K. et. al. "Phase Transformation yield surface of anisotropic shape memory alloys." *Materials Science and Engineering A* 438-440 (2006): 436-440.