

# STEEL MICROSTRUCTURES: PEARLITE AND MARTENSITE

November 30, 2009

# Pearlite

- ▣ Lamellar microstructure is a diffraction grating for visible light
- ▣  $\gamma \rightarrow \alpha + \text{Fe}_3\text{C}$
- ▣ Kinetics of transformation:

$$f = 1 - \text{Exp} \left[ \frac{\pi}{3} N G^3 t^{d+1} \right]$$

N: nucleation rate

G: growth rate

$2 < d < 3$

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Fig. 10-2-2 in Durand-Charre, Madeleine. *Microstructure of steels and cast irons*. New York, NY: Springer, 2004.

Fig. 9.29 in Callister, William D. *Materials Science and Engineering: An Introduction*. Hoboken, NJ: Wiley & Sons, 2007.

# Pearlite

- ▣ Habit planes
- ▣ Characteristic spacing,  $\lambda$

$$\lambda \propto T$$

$$\sigma_{h-p} \propto \frac{1}{\sqrt{\lambda}}$$

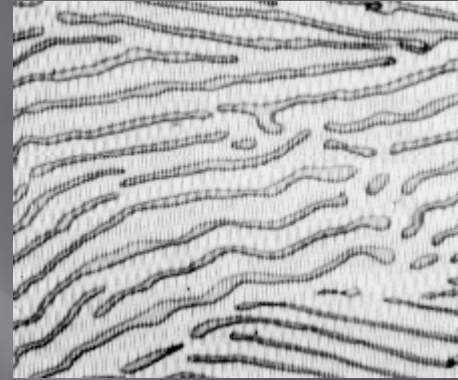
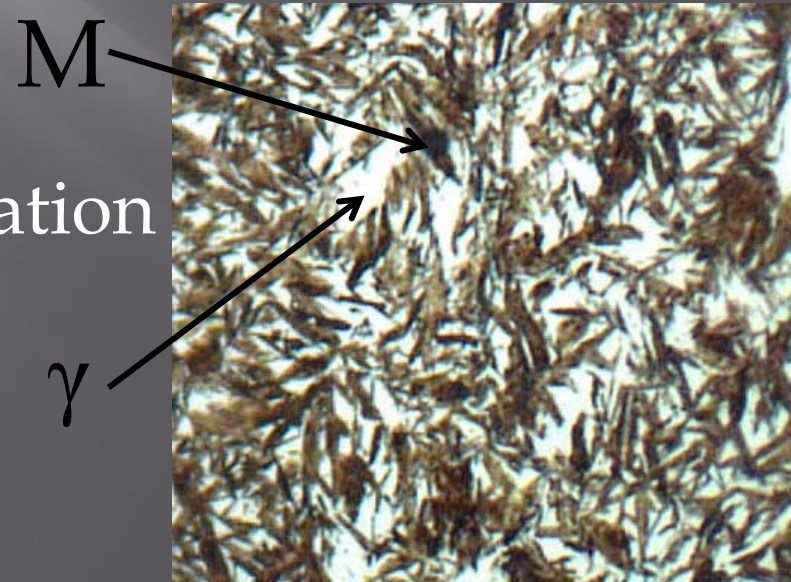
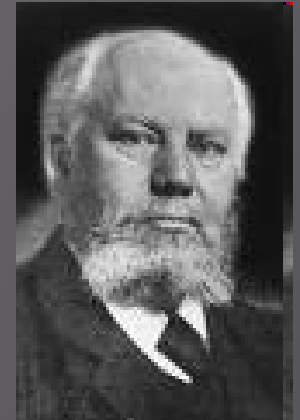


Image removed due to copyright restrictions. Please see Fig. 1 in Zhang, Y. D., et. al. "New insights into crystallographic correlations between ferrite and cementite in lamellar eutectoid structures, obtained by SEM-FEG/EBSD and an indirect two-trace method." *Journal of Applied Crystallography* 40 (2007): 849-856.

# Martensite Structure

- ▣ Named after Adolf Martens
- ▣ Diffusionless, military transformation
  - Same chemical composition as parent
  - Sharp interfaces
- ▣ Similar to twinning
- ▣  $\gamma$  (FCC)  $\rightarrow$  M (BCT)
- ▣ Not a complete transformation



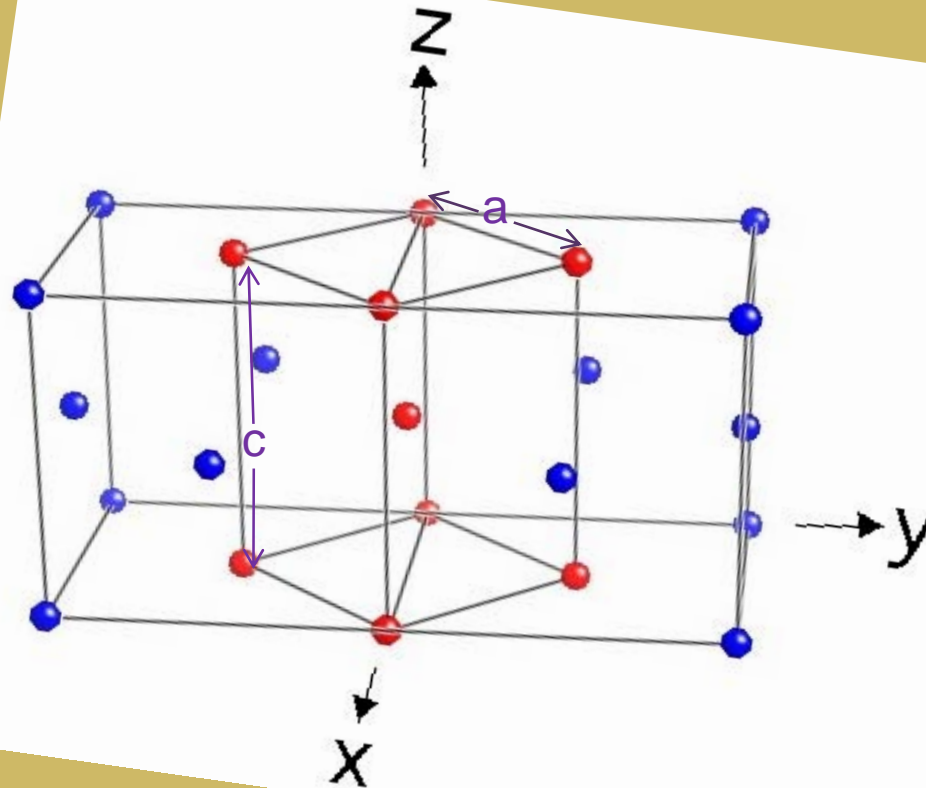
# Cu-Al-Ni Austenite to Martensite transformation

Please see the [movie](#) at Sethna, Jim. "[What are Martensites?](#)" Cornell University, 1996.

# Martensite Reaction

$\gamma$  (FCC)

$$\frac{c}{a} = 1.4$$



M (BCT)

$$1 < \frac{c}{a} < 1.4$$

Courtesy of Harry Bhadeshia.  
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# Alloying Effects

- ▣ Diffusion and growth are slower
- ▣ Change in eutectoid temperature
- ▣ Change  $M_s$  temperature

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THE END



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