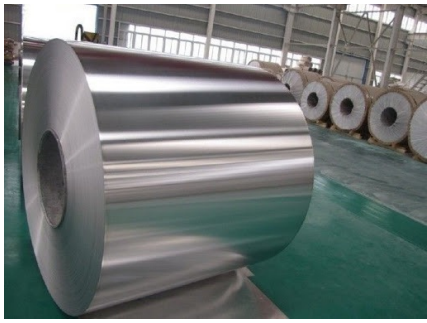
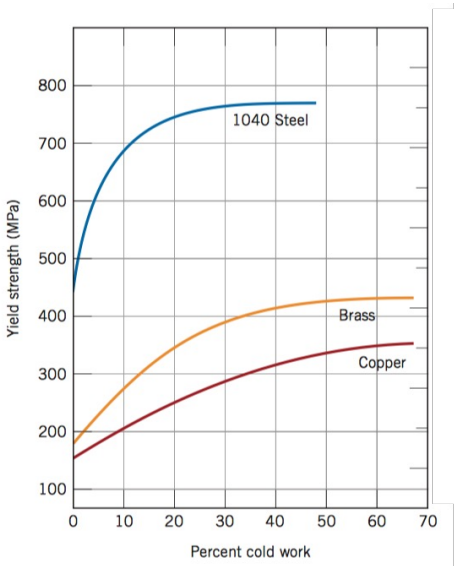
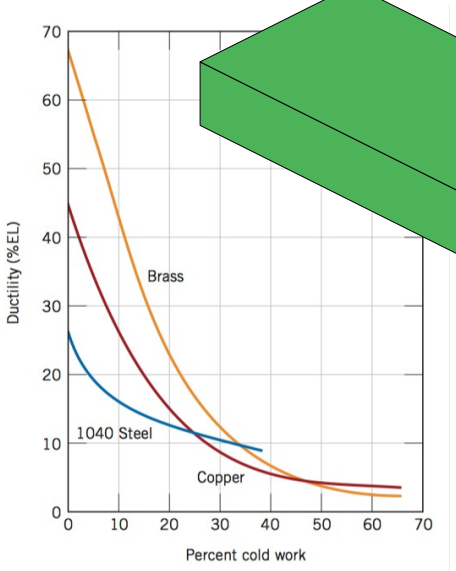
7.3 回复-再结晶-长大

Dongsheng Wen

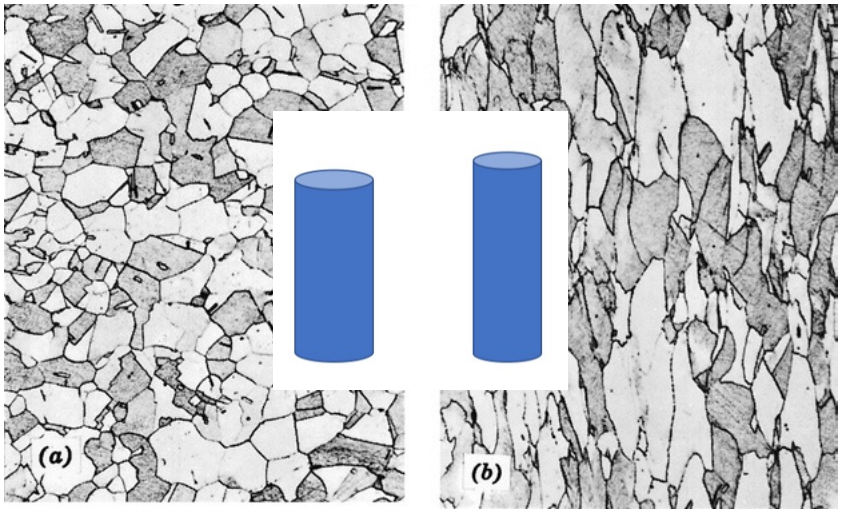
加工硬化后的 “问题”

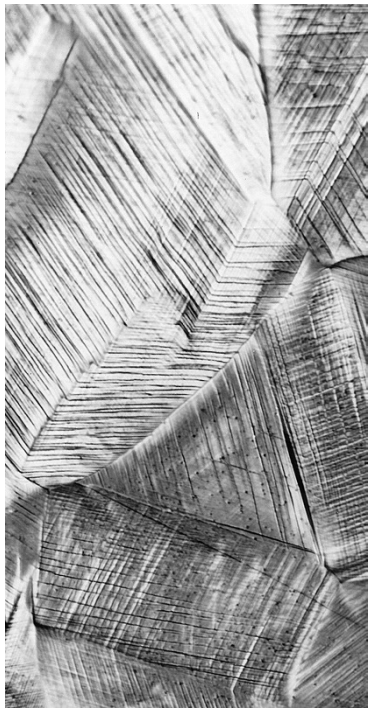


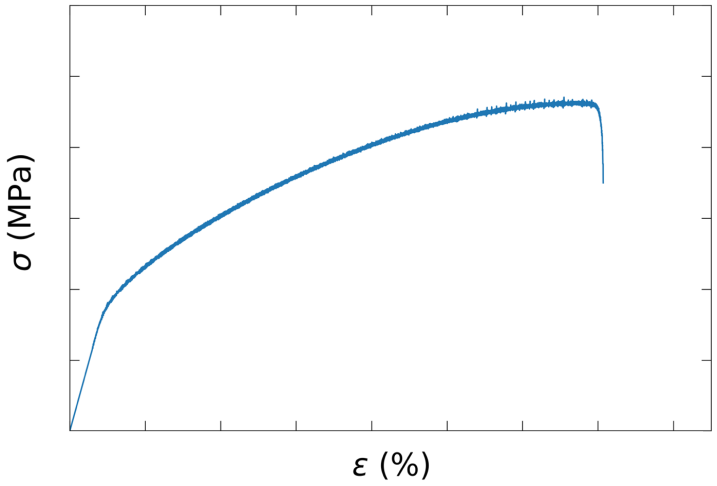

Yield strength (MPa)
800
700
600
500
400
300
200
100
0
10
20
30
40
50
60
70
Percent cold work
1040 Steel
Brass
Copper


Ductility (%EL)
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Percent cold work
Brass
1040 Steel
Copper

加工硬化的微观组织

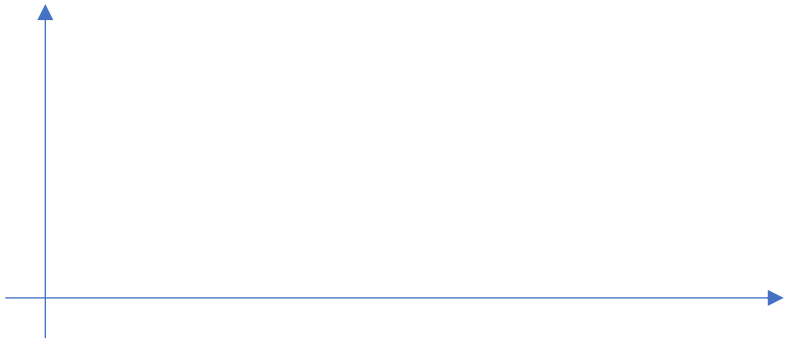




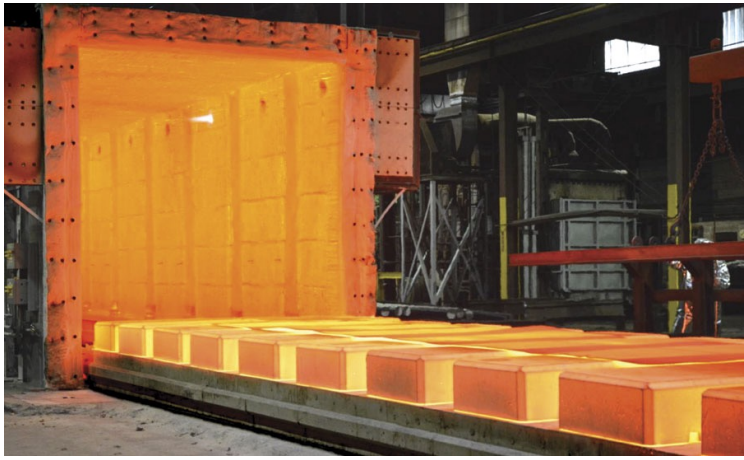


回复-再结晶-长大：温度与时间的故事

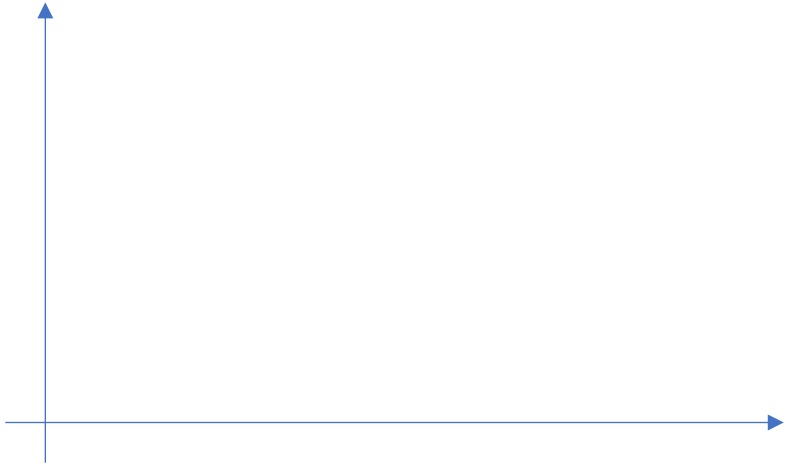
- 做两个实验：对于一个已经加工的材料。
  - 控制同一个温度(T)，看材料微观/性能 vs. 时间(t)



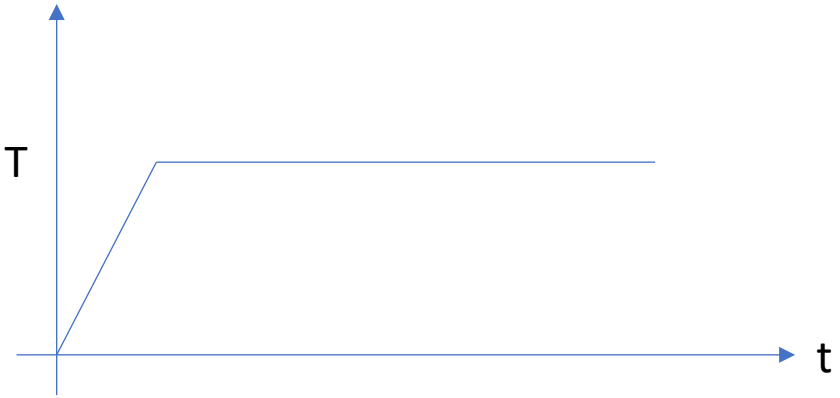
Donovan Heat Treating Co. Inc.



  - 控制同一个时间(t)，看材料微观/性能 vs. 温度(T)



控制同一个温度(T)，看材料微观 vs. 时间(t)



33 %. CW

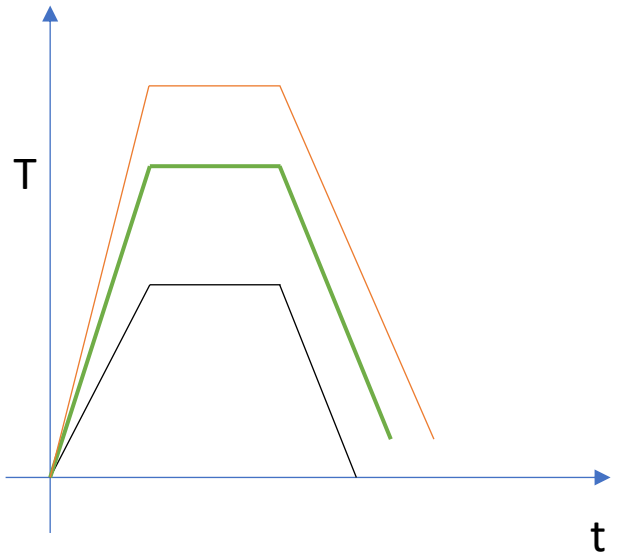
580 ˚C, 3s

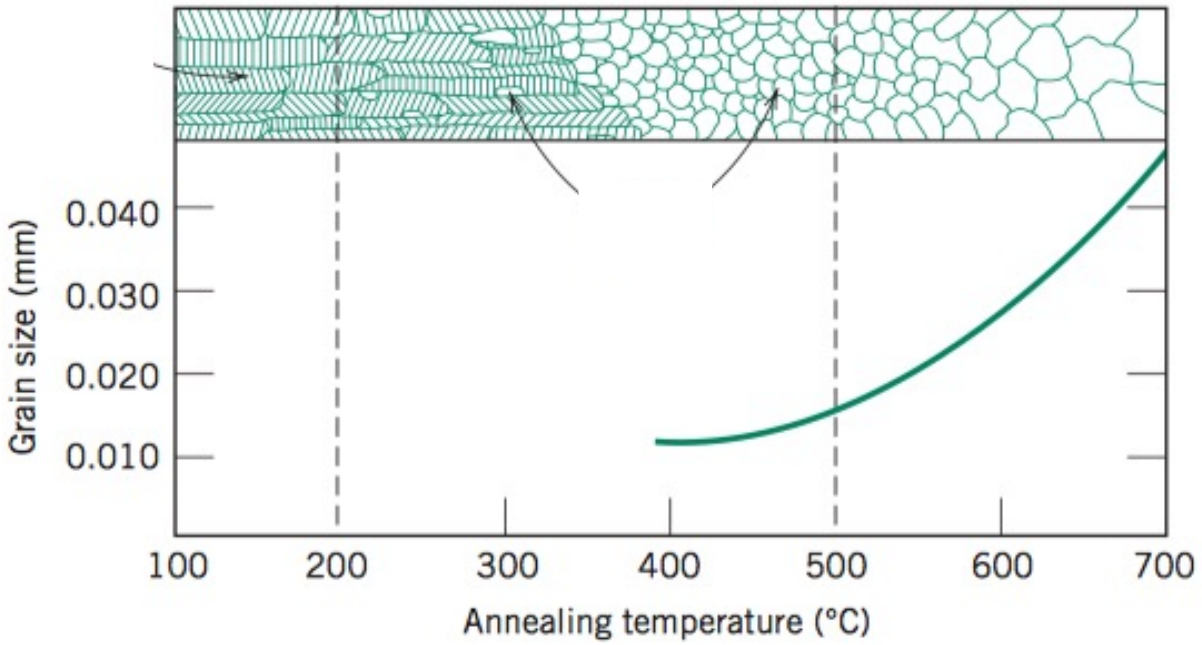
580 ˚C, 4s

580 ˚C, 8s

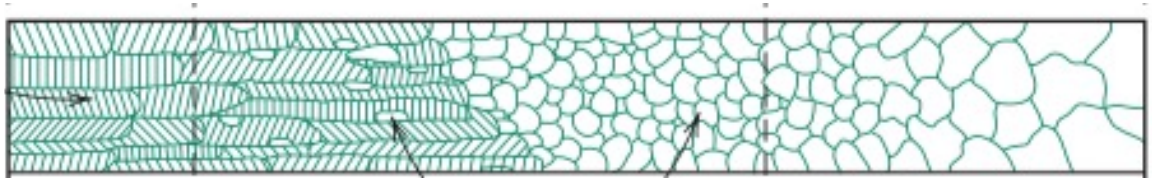
580 ˚C, 15 min

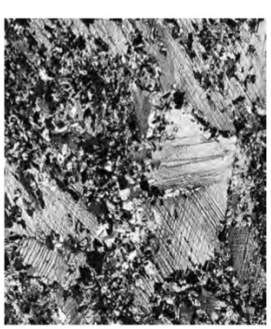
控制同一个时间(t)，看材料微观 vs. 温度(T)

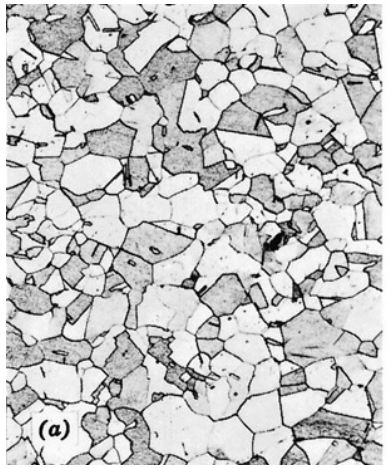




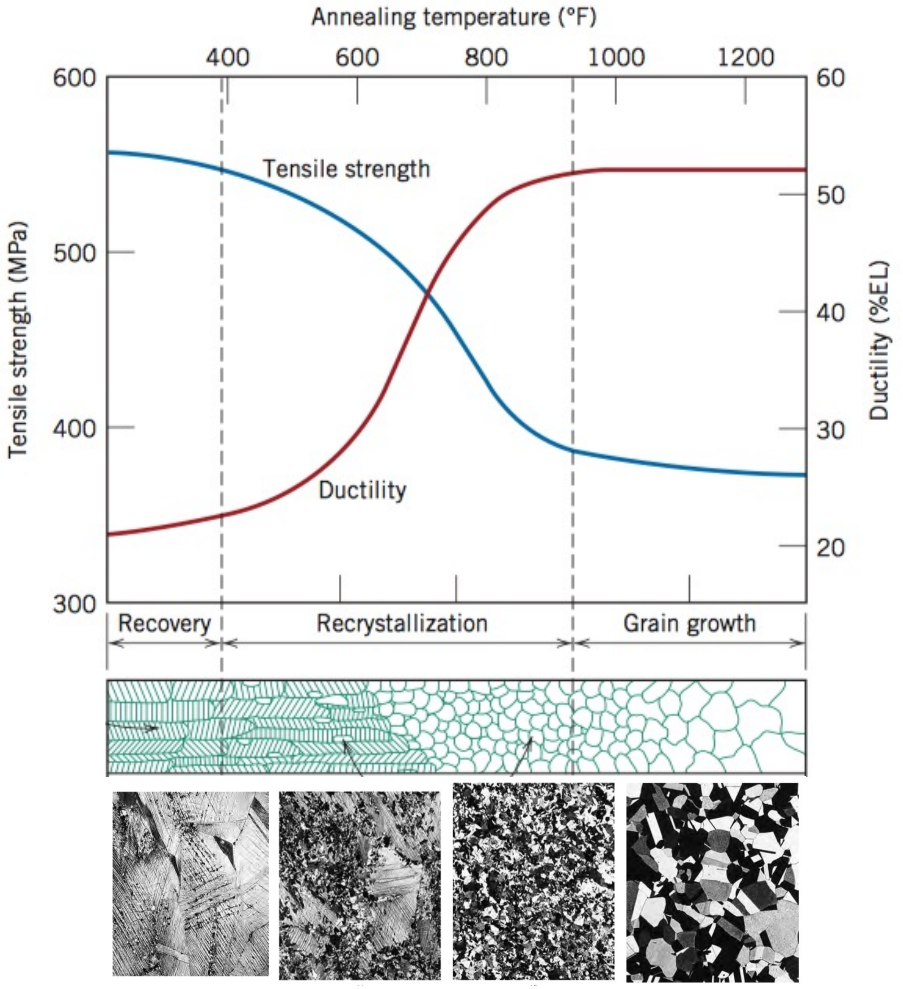
回复-再结晶-长大



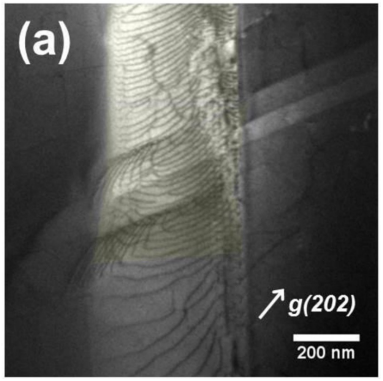


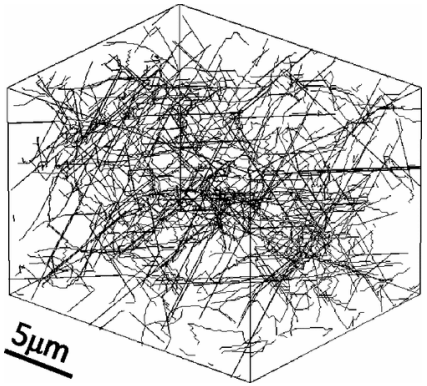


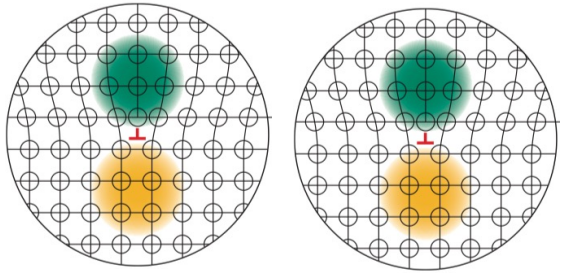
回复-再结晶-长大：与力学性能的关系



为什么可以这样做热处理？？？

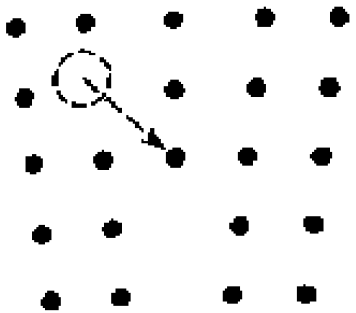


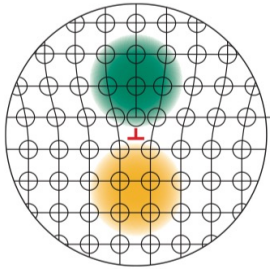


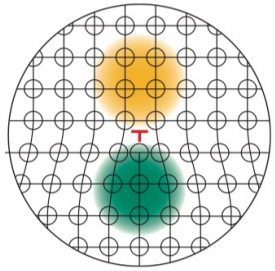


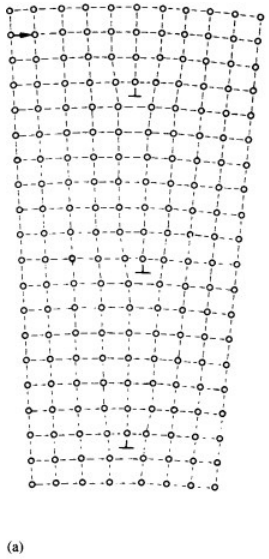
Kim, S., Park, J.Y., Park, S. et al. Direct observation of dislocation plasticity in high-Mn lightweight steel by in-situ TEM. Sci Rep 9, 15171 (2019).
Madec, R., Devincre, B. and Kubin, L.P., 2002. From dislocation junctions to forest hardening. *Physical review letters*, *89*(25), p.255508.

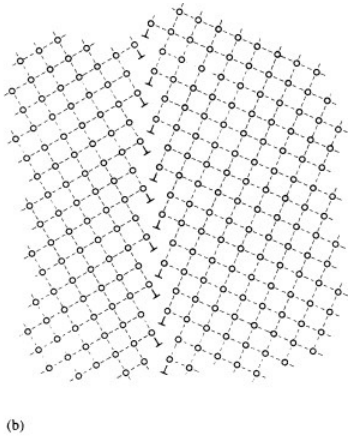
回復 (recovery)

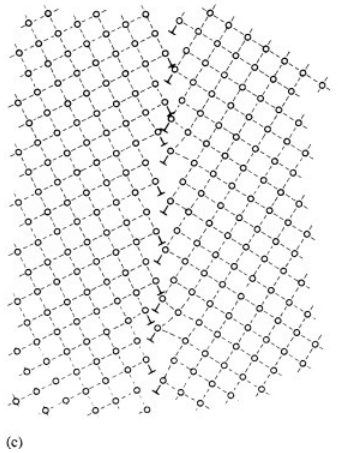






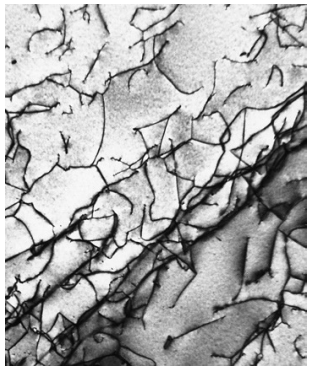


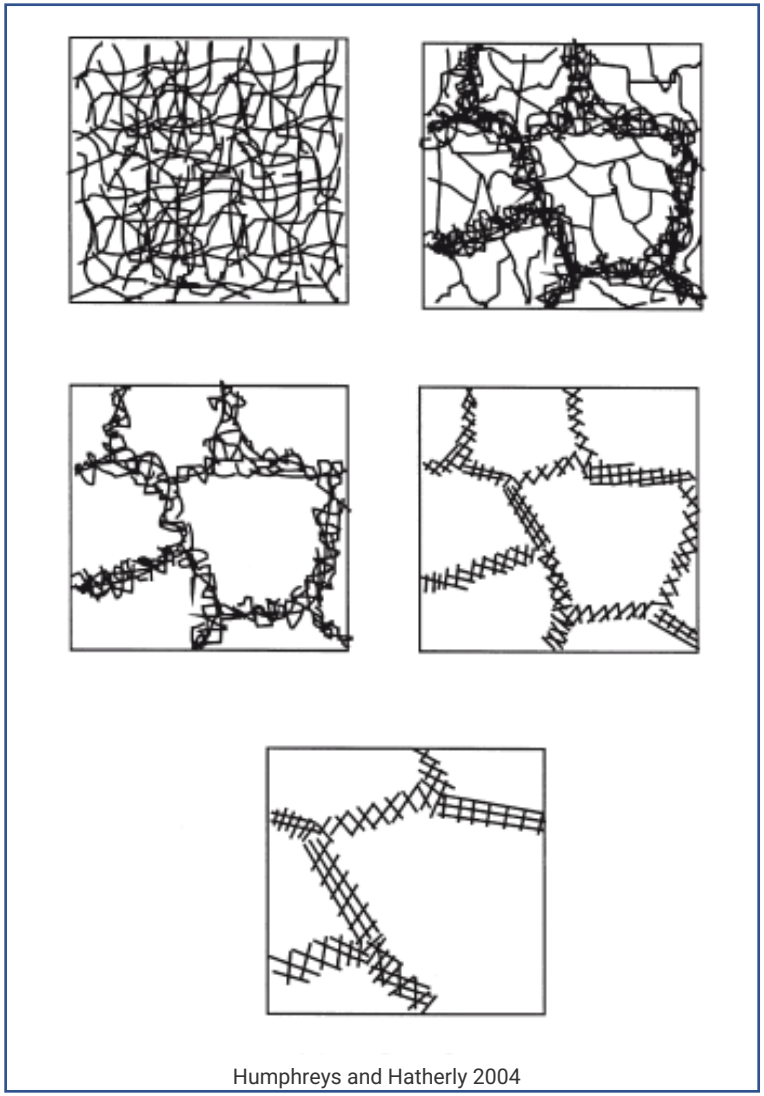




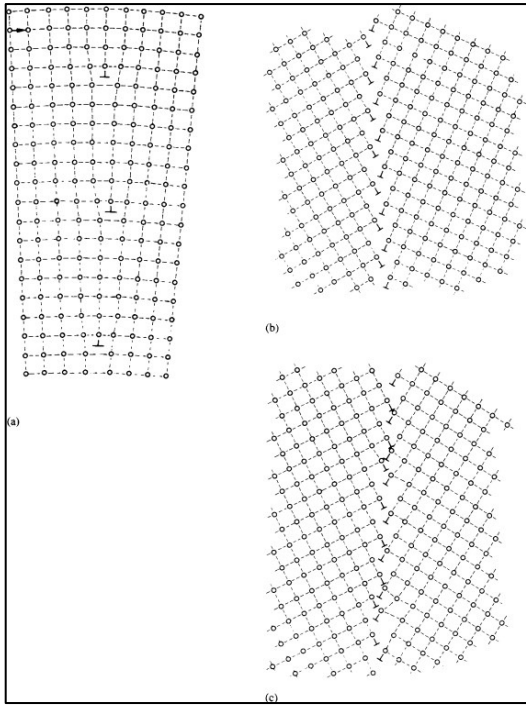
Madec, R., Devincre, B. and Kubin, L.P., 2002. From dislocation junctions to forest hardening. *Physical review letters*, *89*(25), p.255508.
MICROSTRUCTURE H. GLEITER, in Physical Metallurgy (Fourth Edition), 1996

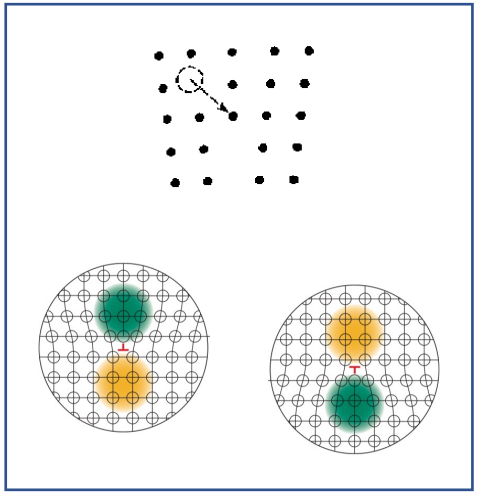
回复 (recovery)

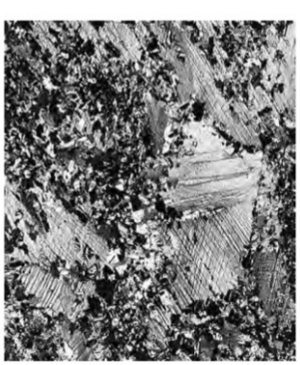




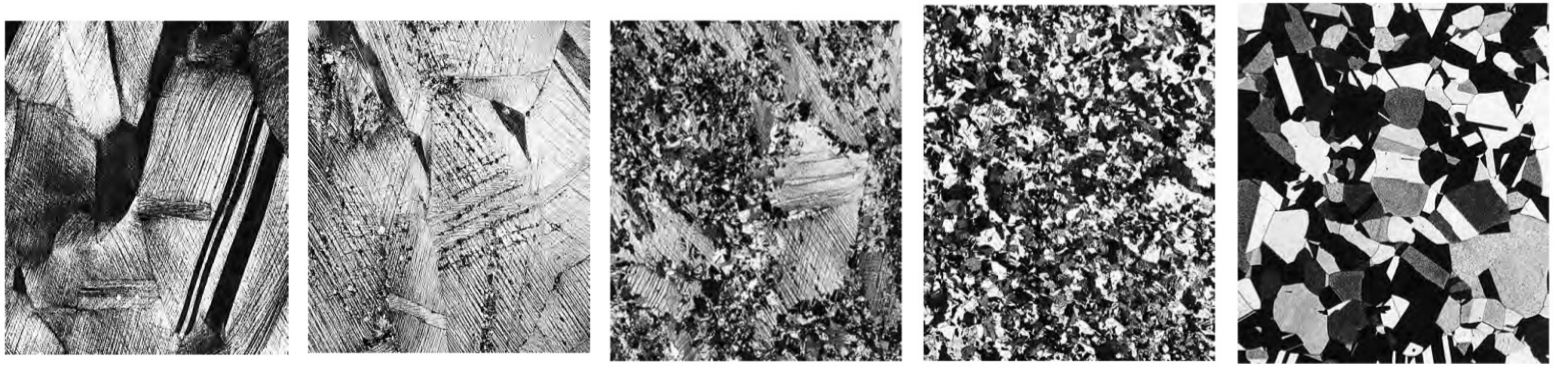
Humphreys and Hatherly 2004

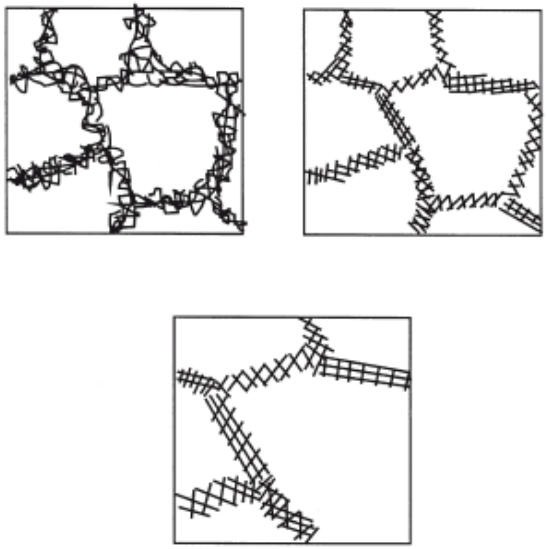


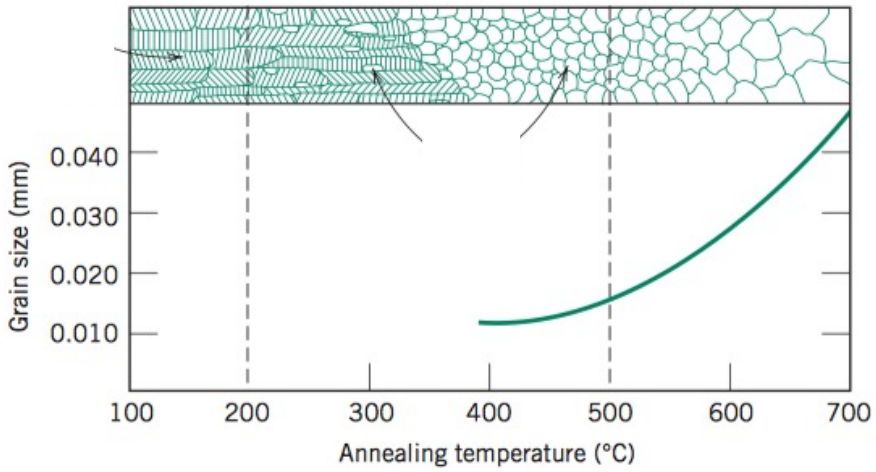




再结晶 (recrystallization)

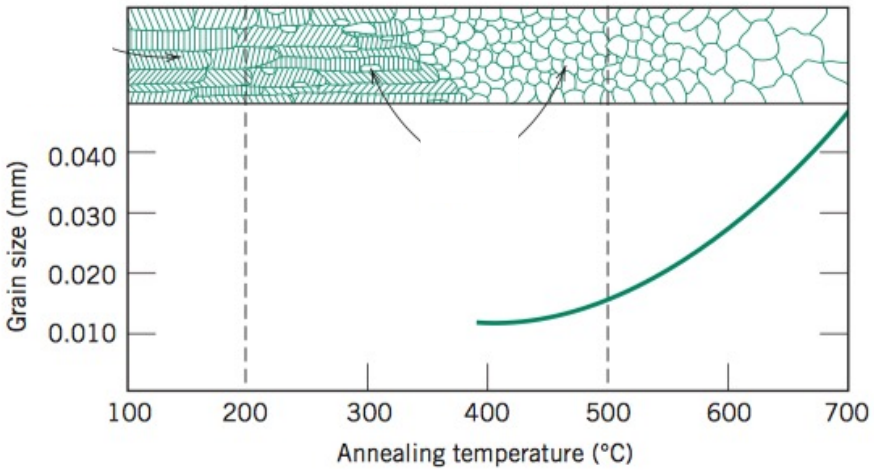


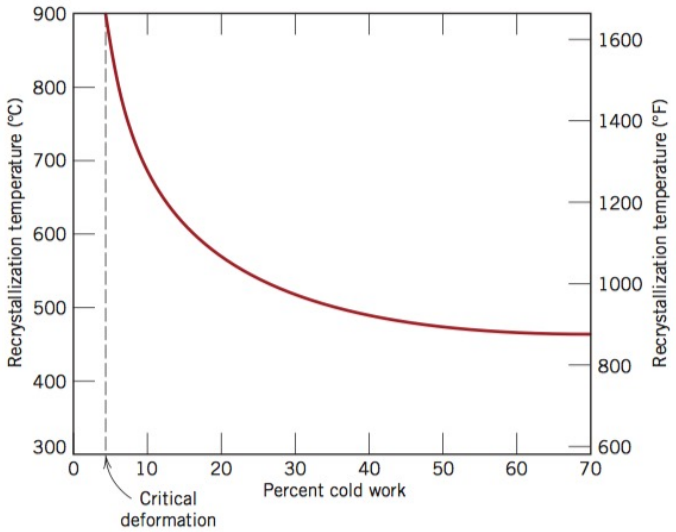




Humphreys and Hatherly 2004

再结晶温度 (recrystallization temperature)





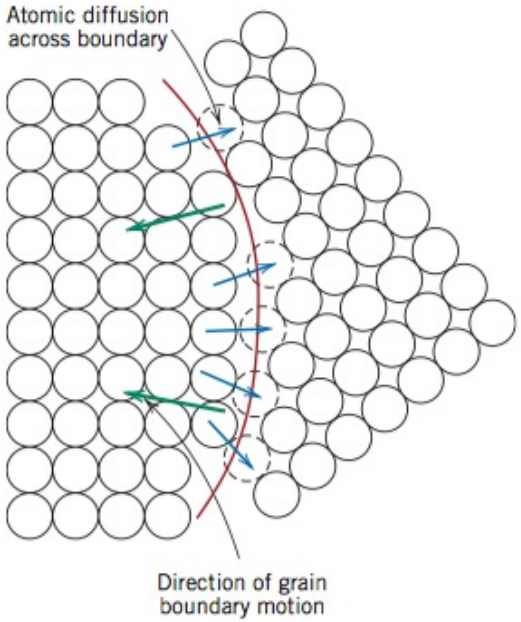
再结晶温度：冷加工与热加工

冷加工：

热加工：

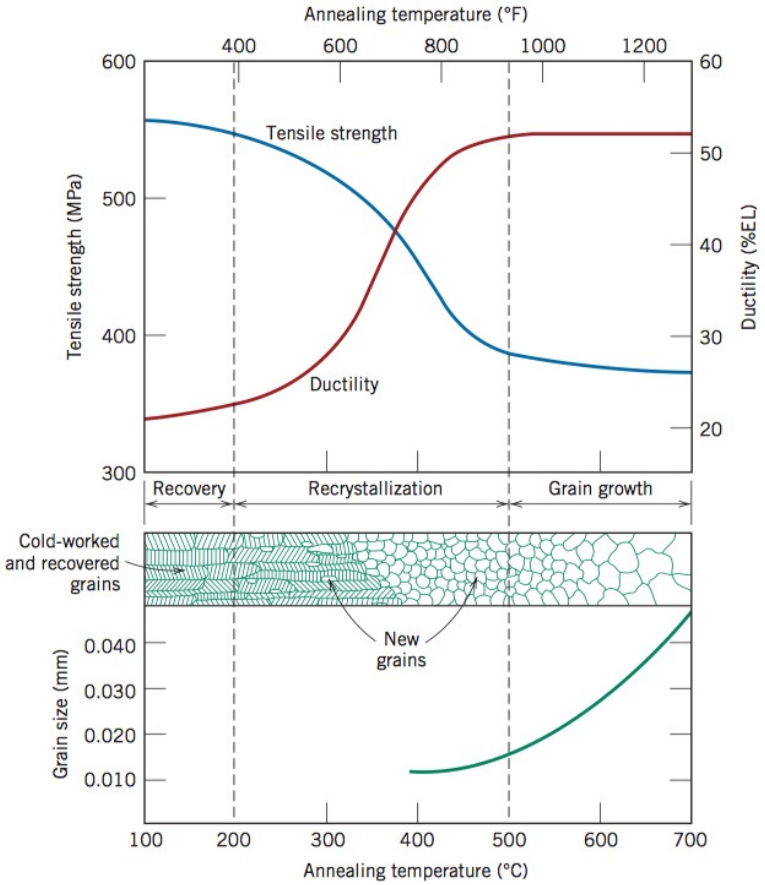
材料	熔点 (K)	再结晶温度 (K)
Fe	1,811	~ 723 (450 ˚C)
Al	933	~ 353 (80 ˚C)
Pb	600	~ 269 (-4 ˚C)
Sn	505	~ 269 (-4 ˚C)

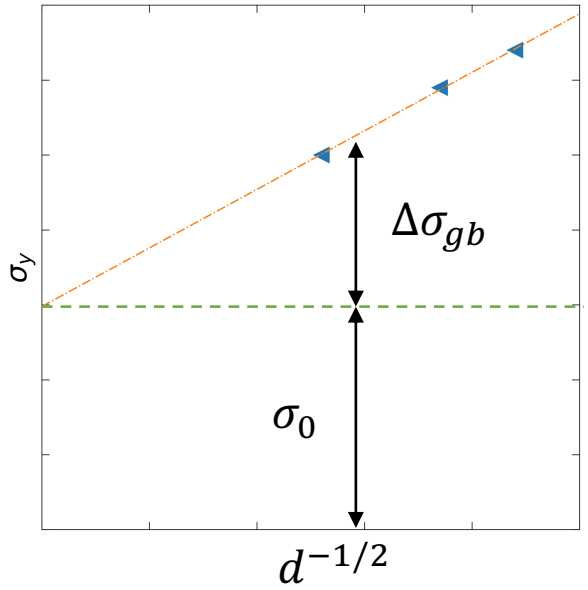
晶粒长大 (grain growth)



变形-回复-再结晶-长大与晶粒细化强化

- 加工后 – 热处理 – 加工前





8. 断裂
9. 高分子材料力学性能
10. 扩散
11.简单相图