Lesson 06: Plastic deformation and strengthening

Exercise 06.1 Cupronickel

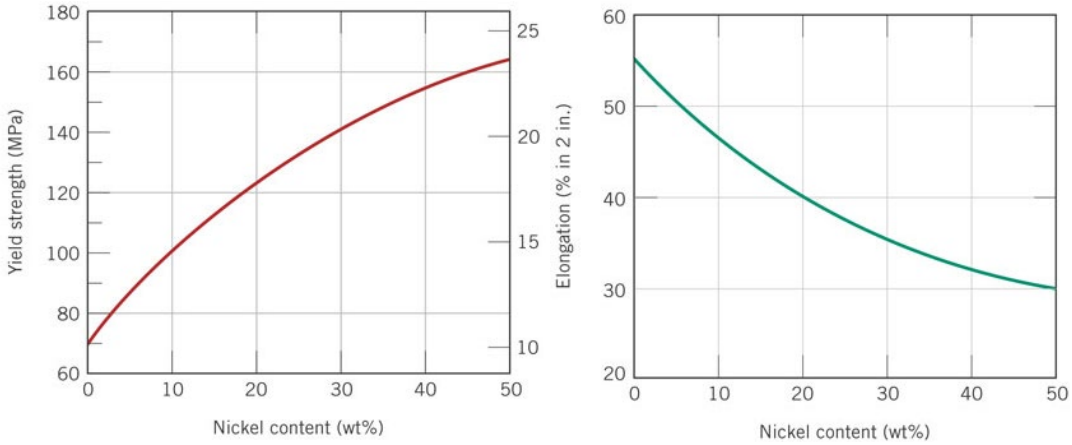
Sketch (qualitatively) the flow curves of the following materials in a common stress strain diagram.

a) Pure annealed copper
b) Cupronickel with 25 wt.% Ni
c) Cupronickel with 44 wt.% Ni (Konstantan)

Compare the three flow curves with respect to their Young's modulus, yield strength, tensile strength and ductility (can be found in presentations of lecture 05 and 06). Why do the curves look different?

Exercise 06.2 Copper Nickel alloys with high Ni content

The dependence of yield strength and ductility of cupronickel is shown below for compositions with maximum nickel content of 50 wt.%. How do the curves continue to higher nickel contents and to pure nickel?



Sketch the dependence of the electrical conductivity of the alloys in dependence on the nickel content.

Exercise 06.3 Brass

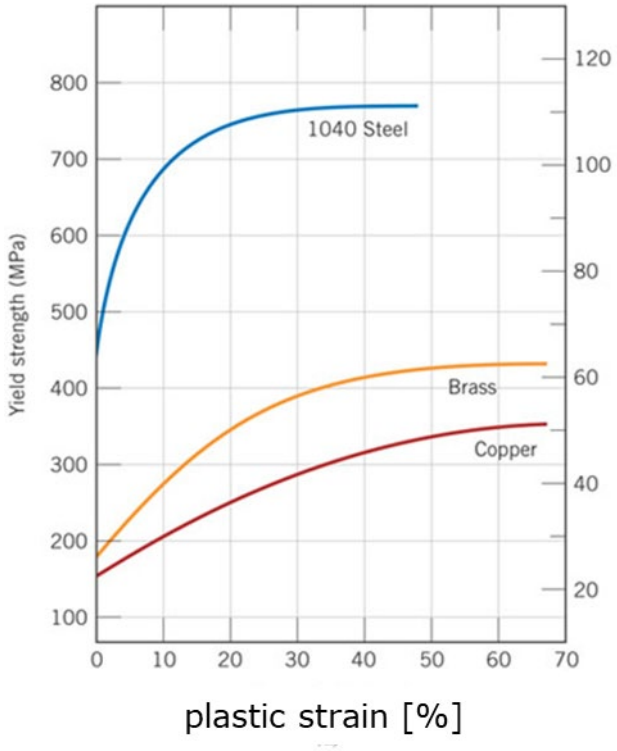
Sketch the flow curve of (alpha) brass (copper with 30 wt.% zinc) after five different treatments in one and the same stress strain diagram:

a) Undeformed brass with grain size 8 µm
b) Brass with grain size 8 µm deformed to 20 % strain
c) Brass with grain size 8 µm deformed to 50 % strain
d) Undeformed brass with grain size 100 µm
e) Brass with grain size 100 µm deformed to 20 % strain

Compare the flow curves with respect to their Young's modulus, yield strength, tensile strength and ductility. Why do the curves look different?

Exercise 06.4 Pure copper

Pure copper with a relatively large grain size (500 µm) and a low dislocation density ($2 \cdot 10^{10}$ m^{-2}) is deformed at room temperature; its flow stress increases as shown in the figure. What is the dislocation density after 30 % and after 60 % plastic strain (M = 3, α = 0.5, $k_y = k_{HP}$ = 0.11 MPa $m^{1/2}$, G = 46 GPa, b = 0.255 nm)?



Exercise 06.5

Assess the yield strength of three specimens:
(A) Pure Cu.
(B) Pure Cu, which has been rolled at room temperature.
(C) A copper alloy with 50 wt.% Ni, which has been rolled at room temperature as (B).
Explain the mechanisms affecting the yield strength assume that all specimens have the same grain size. No quantitative values for the yield strength are required, just compare them using ”larger than” or ”smaller than”.