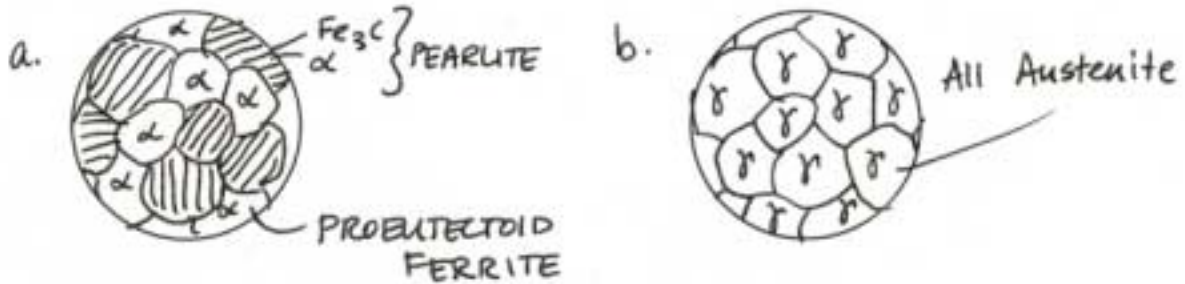


ENGR 240 Science of Materials Homework 14 Solutions (13 points)

- [4 points] Using the Fe-Fe₃C phase diagram, make schematic microstructural sketches for the following conditions. Label the phases and microconstituents in your sketches.
 - Steel with 0.30 wt.% carbon that has been heated to 900 °C and very slowly cooled to room temperature
 - Steel with 0.90 wt.% carbon at 800 °C.

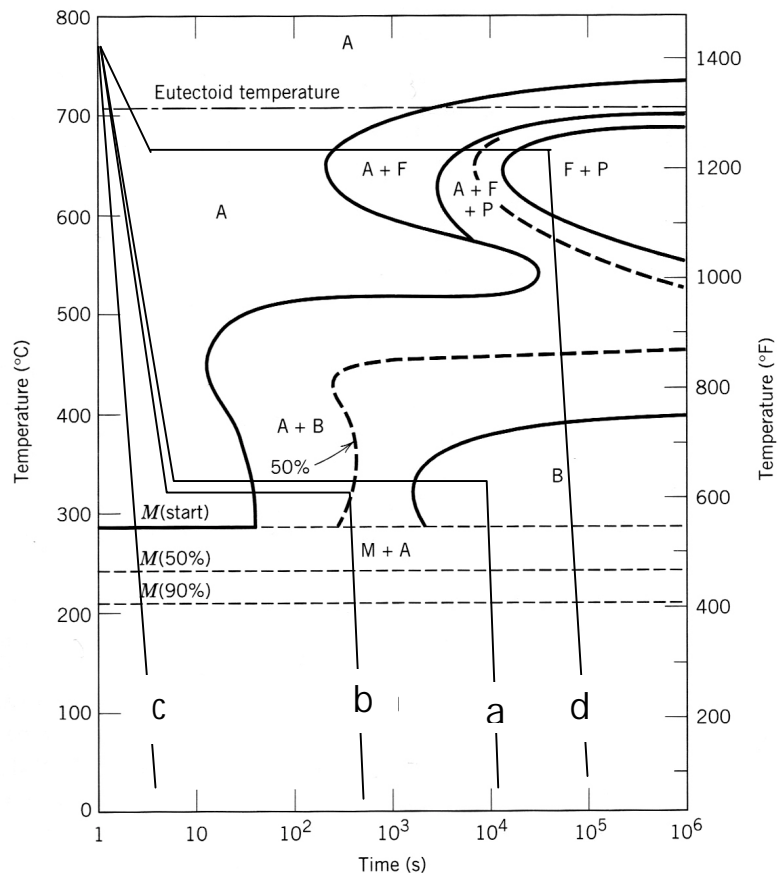


- [1 point] How does the austenite to martensite transformation differ from the austenite to bainite transformation?

The martensite transformation is a diffusionless transformation that involves a cooperative motion of atoms in the change from fcc austenite to bct martensite. Since the austenite to martensite change does not involve diffusion, it occurs very quickly and does not require thermal activation (elevated temperatures). The austenite to bainite transformation depends on diffusion, so it requires both temperature and time.

- [2 points] The TTT diagram for AISI 4340 steel (Fe with Cr, Mo, Ni, and 0.40 wt.% C) is given on the following page. On the TTT diagram, sketch isothermal paths that will result in the following microstructures:

- 100% bainite.
- 50% bainite, 50% martensite
- 100% martensite.
- 100% coarse pearlite + proeutectoid ferrite.

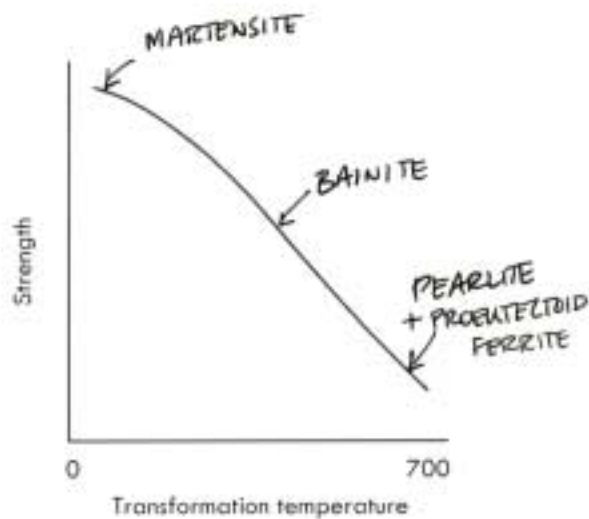


4. [4 points] Given the AISI 1045 steel (plain medium carbon steel with 0.45 wt.% C) TTT diagram on the back of this page, tell what phases and microconstituents will result from the following isothermal heat treatments:

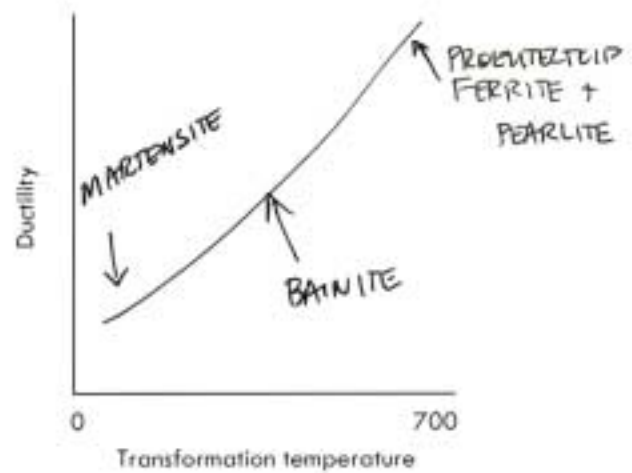
- Austenitize (transform entire sample to austenite phase), cool rapidly to 350 °C and hold for 10 sec, quench in water.
- Austenitize, cool rapidly to 700 °C and hold for 1 minute, quench in water.
- Austenitize, cool rapidly to 600 °C and hold for 10⁵ sec, quench in water.
- Austenitize, quench in water.

- Bainite (ferrite or α phase plus martensite or α' phase)
- This one depends on where you draw your line...it's either proeutectoid or primary ferrite (ferrite or α phase) plus martensite (martensite or α' phase) OR it could be just into the pearlite region, in which case the answer is proeutectoid ferrite (ferrite or α phase) plus pearlite (α and Fe₃C phases) plus martensite (α' phase).
- Proeutectoid ferrite (ferrite or α phase) plus pearlite (α and Fe₃C phases)
- Martensite (martensite or α' phase)

5. [2 points] Use the given AISI 1045 steel TTT diagram to construct schematic plots of the expected trends in (i) strength and (ii) ductility as a function of steel transformation temperature. Use a temperature range of 0 to 700 °C on your transformation temperature axis (x-axis).



DOWNWARD TREND
IN STRENGTH & HARDNESS



UPWARD TREND
IN DUCTILITY