

Precipitation Hardening

11.30 This problem asks us to compare various aspects of precipitation hardening, and the quenching and tempering of steel.

(a) With regard to the total heat treatment procedure, the steps for the *hardening of steel* are as follows:

- (1) Austenitize above the upper critical temperature.
- (2) Quench to a relatively low temperature.
- (3) Temper at a temperature below the eutectoid.
- (4) Cool to room temperature.

With regard to *precipitation hardening*, the steps are as follows:

- (1) Solution heat treat by heating into the solid solution phase region.
- (2) Quench to a relatively low temperature.
- (3) Precipitation harden by heating to a temperature that is within the solid two-phase region.
- (4) Cool to room temperature.

(b) For the *hardening of steel*, the microstructures that form at the various heat treating stages in part (a) are:

- (1) Austenite
- (2) Martensite
- (3) Tempered martensite
- (4) Tempered martensite

For *precipitation hardening*, the microstructures that form at the various heat treating stages in part (a) are:

- (1) Single phase
- (2) Single phase--supersaturated
- (3) Small plate-like particles of a new phase within a matrix of the original phase.
- (4) Same as (3)

(c) For the *hardening of steel*, the mechanical characteristics for the various steps in part (a) are as follows:

- (1) Not important
- (2) The steel becomes hard and brittle upon quenching.
- (3) During tempering, the alloy softens slightly and becomes more ductile.
- (4) No significant changes upon cooling to or maintaining at room temperature.

For *precipitation hardening*, the mechanical characteristics for the various steps in part (a) are as follows:

- (1) Not important
- (2) The alloy is relatively soft.
- (3) The alloy hardens with increasing time (initially), and becomes more brittle; it may soften

with overaging.