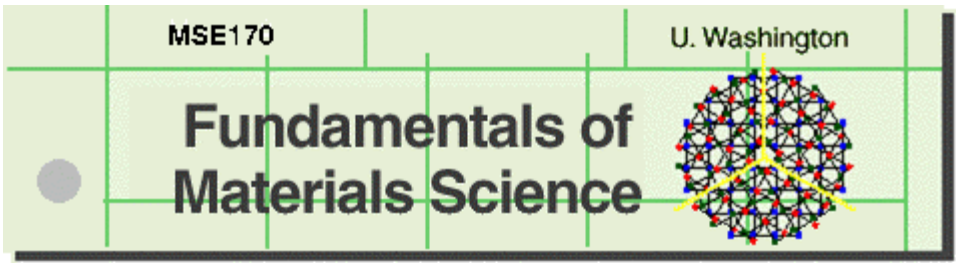

LAB IV
Heat Treatment of Steel

STUDY QUESTIONS:

1. In terms of heat treatment and the development of microstructure, what are two major limitations of the iron-iron carbide phase diagram?

2. Consider the Iron-Carbon Phase Diagram shown in your textbook. For alloys containing 0.5%C, 0.8%C and 1% C, which have been slowly cooled from the austenite region (1100^{o}C) to room temperature, calculate the relative amounts and compositions of the phases present at room temperature. Draw the microstructure which would result in each case.

3. Eutectic alloys often have a lamellar structure (alternating layers). How could cooling rate affect the thickness of the layers?

4. Please answer the following questions about the TTT diagram and phase diagram of a eutectoid steel. How long will it take for the austenite-to-pearlite reaction to go to 75% completion? Why does martensite not appear on the Fe-C phase diagram?

LABORATORY

Objective

• To observe the heat treatment process for a 4340 and a eutectoid steel sample.
• To compare the hardness and microstructure of a 4340 to a eutectoid steel sample, was cooled slowly versus a quenched sample.

Experimental Procedure and Analysis

Each lab will receive four samples to test. We will be using 4340 and eutectoid steel. The steel samples will be austenized at 900 degrees C for half an hour. The samples will then be cooled in two manners. The first will be a slow air-cooling, which should result in a piece approximately in equilibrium. The second piece will be quenched in water resulting in a non-equilibrium sample.

Procedure

1. Heat the samples up to 900 °C and hold for 30 minutes.

2. Cooling the samples:

    a) Take one 4340 and one eutectoid steel sample and quench them in water. They must be removed from furnace and placed in the water very quickly, approximately 1-2 seconds, so everything has to be ready.

    b) Turn off the furnace. Leave the door of the furnace open for 30 minutes to allow the second set of samples to cool.

3. Once the samples are cool they will have to be ground to remove the oxide layer. Take the hardness measurements using a Rockwell C scale. Take 5 measurements on each sample and average the value. Be careful not to place indents too close together as it may affect the results.

4. Look at the microstructures of air-cooled and water quenched steel samples. Polished and etched samples of each type will be provided by the TA's. These samples were polished to a 1 micron finish and then chemically etched to reveal the grain boundaries. View each of the samples, comment on the microstructures in your lab report and make sketches of the microstructures and include them in your report.

Questions

1. Rate the hardness of the samples and explain the properties.

2. How did the different cooling rate affect the microstructure of each steel? Do these microstructures agree with what would be predicted from the TTT diagrams?

3. What is the difference between 4340 steel vs. eutectoid steel?

4. Compare the TTT diagram for eutectoid steel with that of 4340. What are the major differences? Why does pearlite take longer to form in 4340 than eutectoid steel?

5. What would happen to the hardness of samples made of brass (instead of steels) if they were air cooled or water quenched?

6. What would be the effect of quenching the steel samples at oil instead of water?

7. What would happen to the microstructure and hardness if the samples were reheated to 600 degree C for 10minutes and then quenched?

Lab Write-Up

The lab report should address all the questions above but should not consist only of these questions. Please follow the procedures outlined on the homepage and in the lab. Look under lab handouts and report formats.