Lab Experiment # 1

General Metallography and Determination of the Grain size for a Microsection

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Objective

The purpose of this lab is to determine grain sizes of various metal specimens through the use of a metallurgic specific microscope. The lab seeks to allow student to be more familiar with the preparation and examination of microsection process. An analysis of the photomicrograph is done to determine grain sizing using both a actual and to size scale.

Equipment

- Cutting Machine
- Mounting machine
- Grinding machine
- Polishing cloth
- Optical microscope
- Amscope Software
- 1020 Steel
- Bakelite

Procedure

1. Prepare one of your specimens by cutting the material to shape, mounting it, grinding it with sandpaper of different grit then polishing it down. Next, prepare the sample by applying Bakelite to the specimen (etching)
2. Place your material under the microscope for 100 time magnification. Take a photomicrograph of your specimen using the Amscope Software.
3. Use your image to determine grain size using the appropriate scale and equations provided in this report.

To determine the grain size (n) found in each specimen in the drawn boundary box use the following formulas:

$$n = \frac{\ln(n_{100})}{\ln(2)} + 1$$

$$n_{100} = n_m * \left(\frac{M}{100}\right)^2$$

$$n_m = (\#\ fully\ enclosed\ grain) + 0.5\ (\#\ partially\ enclosed\ grain)$$

$$M = \frac{Real\ Length}{Scale\ dimension}$$

$$Error\ \% = abs\left(\frac{true - calculated}{true}\right) * 100\%$$

Results

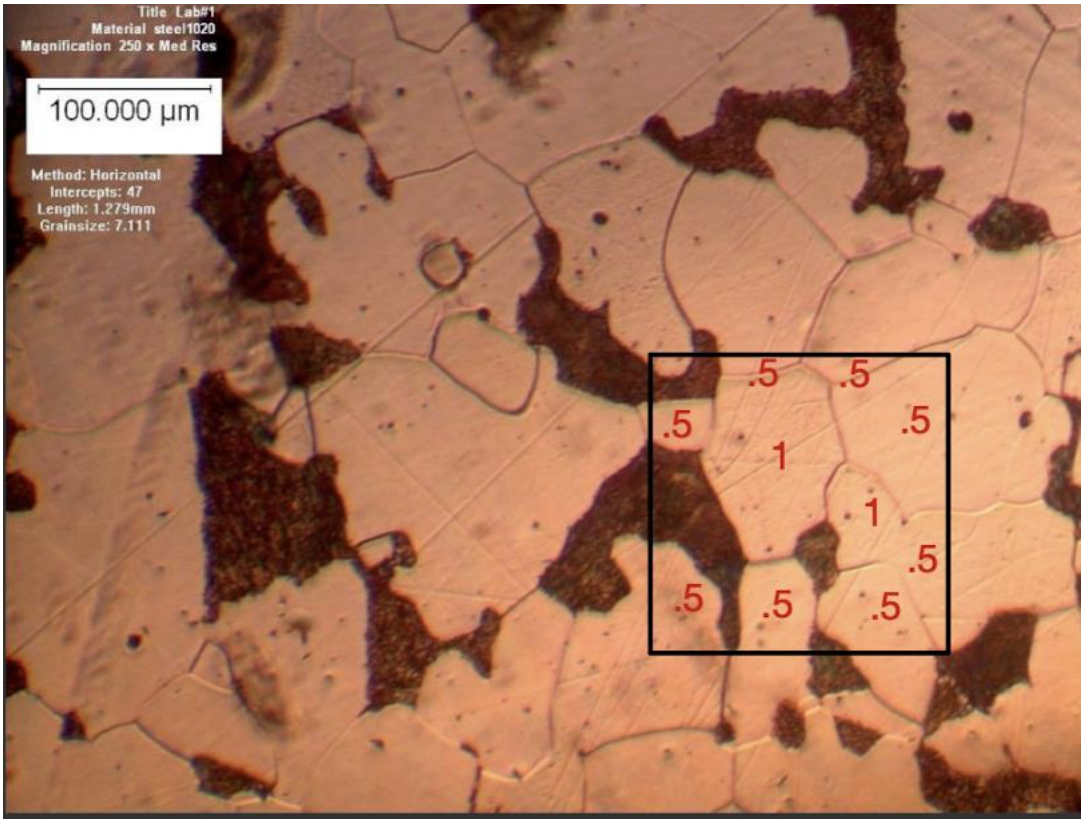

Figure 1: Image of grain boundaries taken to determine grain size of 1020 Steel. Black box represents 1" by 1" boundary used for analysis.

$$M = \frac{2.54\ E - 2\ m}{100\ E - 6m}$$

$$M = 250$$

$$n_m = \ 2 + 0.5\ (8)$$

$$n_m = 6$$

$$n_{100} = \ 6 * \left(\frac{250}{100}\right)^2$$

$$n_{100} = \ 37.5$$

$$n = \frac{\ln(37.5)}{\ln\ (2)} + 1$$

$$n = 6.23$$

$$Error\ \% = abs\left(\frac{7.111 - 6.23}{7.111}\right) * 100\%$$

$$Error\ \% = 12.38\%$$

Discussions of Results

The grain size calculated manually by estimating the amount of ferrit grain present was seen to yield a rough estimate of grain size. Manual calculations found a grainsize of around 6.23 micrometer which yields an error of 12.38%. Such calcution are rough values as seen in figure 1 that grains are often very different sizes. The process of preparing the material for viewing is important in the quality of images as steps such as polishing and grinding helps to smooth surface and remove excess materials. Etching is important to help make analysis easier by clearly defining grain boundaries. Increased accuracy through manual analysis may be determined by multiple samples taken and calculated.

Conclusion

The General Metallography and Determination of the Grain size for a Microsection lab served as a way to understand the steps of proper preparation of metals for analyzing grain size. Many factors come into play to make such process more easy for analysis such as the need for etching to define grain boundaries. Grain size can be roughly found manually through using the appropriate scaling of the microphotograph taken on the metal at magnifications.

Review Questions

1. How and why is the metallurgical microscope different from the biological type?

Metallurgical microscopes use a different light fixture setup to examine a specimen than a biological microscope. No light is passed through the actual specimen used by a metallurgical microscope. They provide a high level of magnification with an reflected light illumination [4]

2. Of what two distinct optical systems is a metallurgical microscope composed?

A metallurgical microscope has 2 optical systems which include an eyepiece lense used for viewing by the person and a objective lense which takes in the image of the specimen being observed.

3. Draw a neat sketch to illustrate the principles of operation of a metallurgical microscope.

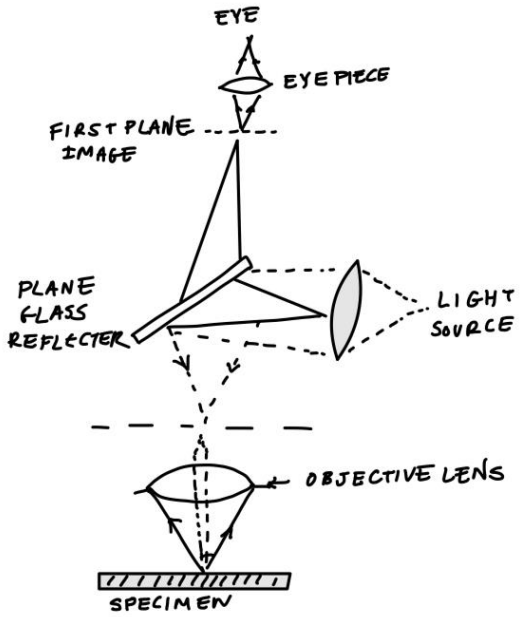

Figure 2: Optical system of Metallurgical microscope

4. Why is grinding (or polishing) conducted in more than one step?

The first process of grinding is used to remove larger materials from the specimen. Different levels of grit is used in grinding to remove more surface level irregularity. After the grinding, a more refined step, polishing is used to improve the surface finish of the material in which rather than various grits of sandpaper, a cloth is used to improve the surface.

5. Why is fine grinding perfomed wet?

Grinding needs water to remove the material as it is happening in order to progress in removing imperfection. When the removed materials remain on the surface, as the grinding process progress, the material will interfere with refinement. Removed material must be taken away from the surface to not further create more imperfections on the surface.

6. What is the purpose of etching?

Etching is used to make grain boundaries more defined when viewing under the microscopes. Etching helps to create more contrast when viewing, making it easier to do analysis of the viewed specimen.

References

[1] CCNY ME 46100 Lab Report Preparation, CUNY blackboard website.

[2] CCNY ME 46100 Lab Manuals, CUNY blackboard website.

[3] CCNY ME 46100 Lab Data, CUNY blackboard website.

[4] https://www.microscopeworld.com/t-metallurgical_microscopes.aspx

[5] https://www.keyence.com/products/microscope/digital-microscope/resources/optical-microscopes/metallurgical-microscopes.jsp