University of Jordan

Macroscopic Examination

9

Properties of Engineering materials lab

contents

Alaa Adel Saqr 0201373

Saleem Elias Bouri 0202428

Omar Naser Sowan 0204768

Lana Ahmad Alsaleh 0204152

Nadeem Ghanem Aljamal 0204566

Safety

Safety is a state in which hazards and conditions leading to physical, psychological, or material harm are controlled to preserve the health and well-being of individuals and the community.

Before starting the experiment in laboratory, we must follow safety rules:

1- Wear your lab coat.

2- Do not hold a workpiece by hand. Workpiece will become very hot while being cut.

3- Do not taste or sniff chemicals.

4- Safety glasses, Hearing protection, gloves, mask, and Sturdy footwear should be worn in work areas.

5- Rings and jewelers must not be worn.

6- Long and loose hair must be contained.

7- Close fitting / protective clothing must be worn.

Objectives

The macro examination in this experiment can be used to estimate the number, size, and distribution of non-metallic inclusions, the structure of the metals and alloys, and residual ingot flaws, such as porosity, folding lines and other flaws, that can be determined by using photosensitive paper that has been previously immersed in sulphuric acid solution H_2SO_4. So, this experiment allows us to distinguish the size, kind, and shape of the grains in each alloy.

Materials and Apparatus

MATERIALS :

- Rod of iron
- Rod of aluminum
- H_2SO_4
- H_2O
- saws
- Rubber Gloves
- Mask
- Tongs
- Flask
- Sandpaper (silicon carbide paper 120,180,240,400)
- Photographic paper
- Safety glasses
- Lab coat
- Alcohol

APPARATUS :

- Cutting machine
- Grinding machine
- Fume hood

Experimental procedure

In metallography there are two types of examination: microscopic & macroscopic.

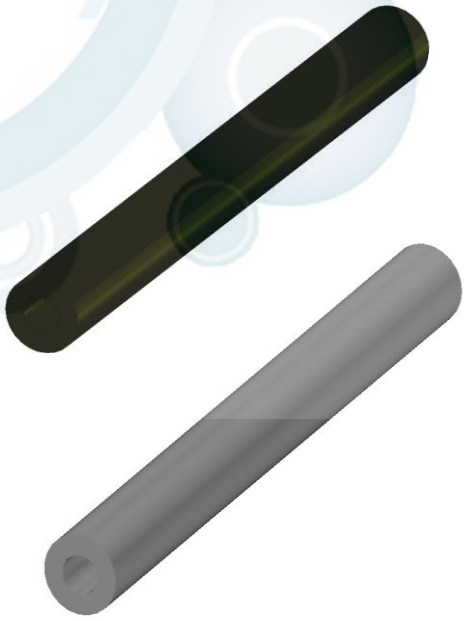
- ✓ **Macroscopic examination**: in this process the internal structure reveals by naked eye or low magnifying Lens.

- ✓ **Microscopic examination**: in this process the internal structure reveals by high magnifying Lens. Anyway, in this experiment we will examine and analyze the specimen macroscopically.

But before we start examining the specimen, we must prepare the specimen for examination through the following steps:

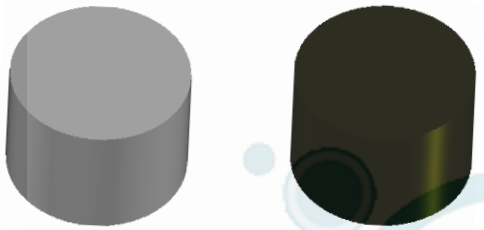
1) Specimen selection:

- We need to choose the material that the sample consists of, which in this experiment is steel and aluminium.
- The number, location, orientation of the sample examined are an important parameter.



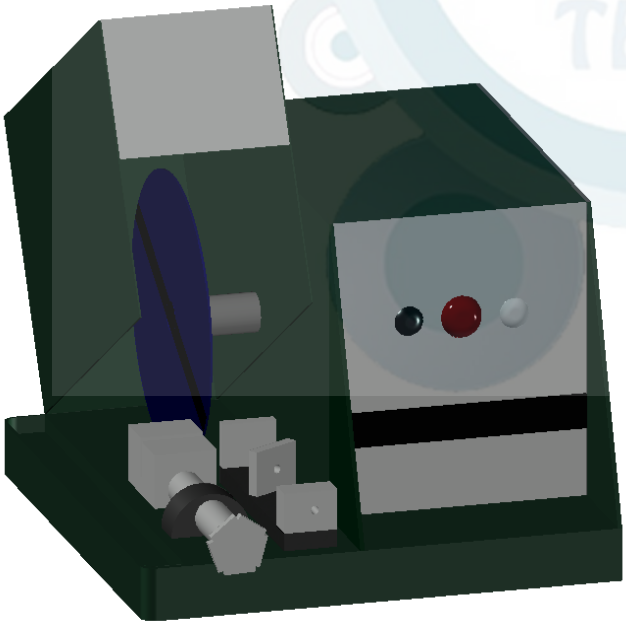
2) Sizing:

- Cube: each side (12-25 mm)
- cylinder: the height and the diameter (12-25 mm).



3) Sectioning or Cutting:

- It is performed carefully to avoid altering the structure of the material.
- Abrasive cutting is the most common cutting method and that what we were used in our experiment.



- the cutting tool is made of silicon carbide (Sic) of diamond particles.
- we used a coolant fluid to avoid overheating of specimen & possible change in material structure.

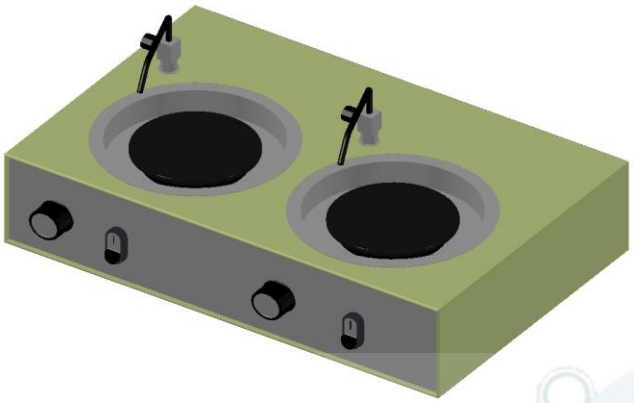
4) Mounting:

{but we didn't do it in the laboratory because there was no need for them}

Small samples can be difficult to hold safely during grinding & polishing operations, and their shape may not be suitable for observation on a flat surface. They are therefore mounted inside a polymer block or mount.

5.) Grinding:

- Grinding is done using rotating discs covered with silicon carbide paper and water.
- There are several grades of paper, with [120, 180, 240, 400] Grains of silicon carbide per square inch or cm.
- 180 grade therefore represents the coarsest particles & this is the best grade to begin the grinding operation with.
- Light pressure applied at the center of the sample.



- We wash the sample in water & move to the next grade, orienting the scratches from the previous grade normal (perpendicular) to the rotation direction. This makes it easy to see when the coarser scratches have all been removed.
- After the final grinding operation done, we wash the sample in water followed by alcohol & dry it before moving to the polishing.

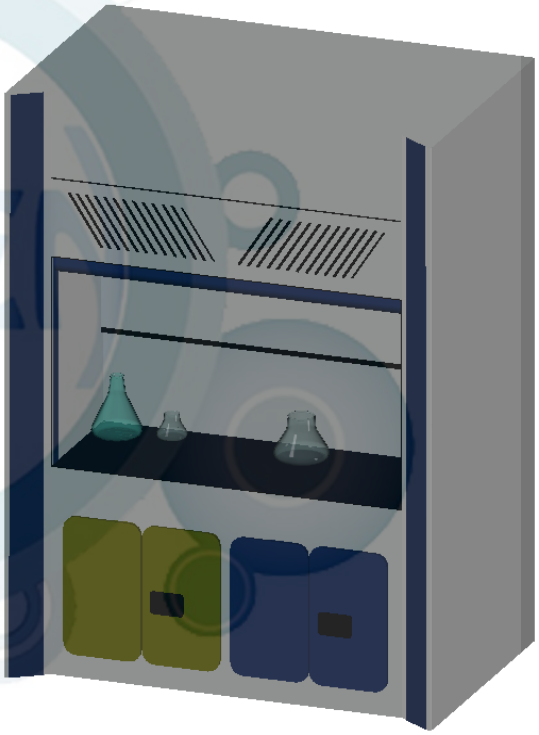
6) Polishing:

{**we didn't do it in the laboratory**}.

7) Etching:

Is the process of clarifying the crystalline boundaries (in technical terms grains boundaries) by using a chemical solution, depending on the type of metal (we can know which solution "etchant" to use from particular tables) where:

- The sample is immersed in this solution using tongs.
- the solution that steels immersed in consists of: [**25% HNO_3, 75% H_2O**]
- the solution that aluminum immersed in consists of: [**15% HF ,35% HNO_3 ,25% HCl ,25%H_2O**]
- Then the sample washed with water & methyl alcohol.
- Finally, sample is dried under a hairdryer.



8.) Sulfur printing:

{this step was done only on some of the samples}

First of all, the purpose of using Sulphur printing is to detect and permanently record the distribution of Sulphur in steel.

➢ *The procedure:*

- Photographic bromide paper is soaked in a (15% H_2SO4, 85% H_2O) for approximately 3 or 4 min.
- the paper is removed from the acid solution and allowed to drain free from excess solution.
- The emulsion side of the paper is then placed in direct contact with the prepared specimen surface & allowed to remain in contact under moderately applied pressure for 1 or 2 min.
- Care must be taken that all entrapped air bubbles between the paper & the specimen surface are eliminated.
- Reaction which occurs between paper & sample is given as:
  $FeS + H_2SO_4$ -------> $FeSO_4 + H_2S$
- The reaction of the sulphuric acid with the sulphide region of the steel produces hydrogen sulphide gas, which reacts with the silver bromide in proper emulsion, forming brown color deposit of silver sulphide.
- The reaction which occurs is given as: $H_2S + 2AgBr$ ---------> $Ag_2s + 2HBr$
- When the reaction has proceeded for approximately the recommended length of time, the photographic paper is removed from the surface of the specimen, rinsed in clear running water, and then fixed permanently by placing it in a photographic fixing solution for about 15 min.

Results and discussion

Discussion

1) The first step done in our experiment, was to select a specimen either from aluminium (AL) or iron (Fe), but before that, we had to cut the rods by using the cutting machine in the lab, because it didn't have the desired size we wanted.

2) The next step was grinding, where took turns to do it, the process of grinding required us to place the specimen on the grinding machine with papers of sizes (120,180,240,400) & while the machine was on , the instructor told us to open the machine's water tap in order to prevent the specimen from having fractions that cause deformation due to high temperature, also we had to rotate the specimen 90 degrees when changing the griding paper.

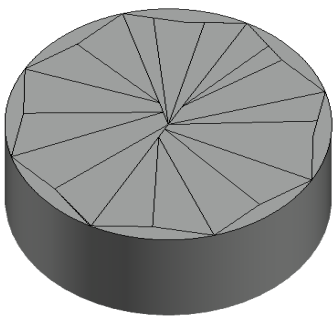
3) After a couple of minutes, the specimen was ready for the next step by putting the specimen on the photography paper that dipped in a solution of H_2SO_4 with (15%) concentration and H_2O with (85%) concentration to know the distribution of carbon and when a black dot appears , this is evidence of welding in this area , after this we do etching by dipping the specimen in chemical solution (Al specimen in 15% HF, 35% HNO_3,25%HCl,25% H_2O) ,(iron specimen in 25% HNO_3 ,75% H_20) to know which specimen had a fast cooling or slow cooling.

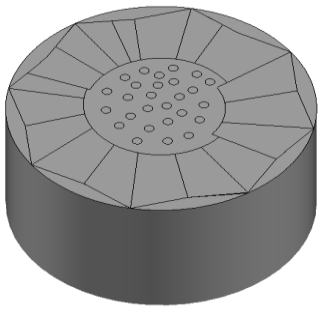
4) Finally, after we were done with etching, we washed the specimen with water, and our experiment was done.

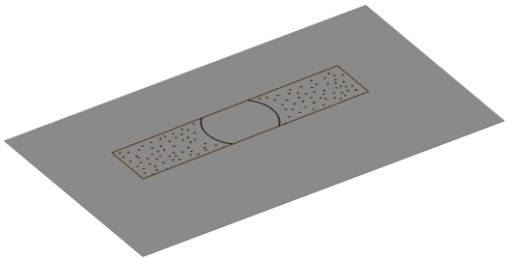
Results

There are different results obtained from this experiment, as in the sulfur printing: dark brown spots were detected.

On the other hand, in the welded areas the properties of the specimen changes after the welding process.







Conclusion

We learn how to make a macroscopic examination for a different material and having the structure by the reaction with chemical solution surface, so we came to the following conclusions:

The tests' results were different for each specimen, which resulted to differences in the prints. We noticed that sulfur printing produced brown spots, but when a specimen was welded, the properties of the specimen changed, and no brown spots were seen in the welded area.

The usage of different cooling procedures directly impacts the appearance of equiaxed grains in aluminum. Based on the results of our experiment, using slow-cooling procedures will eventually result in equiaxed grains, but using fast-cooling procedures won't.

We found that the carbonization process resulted in the edges of the steel becoming blacker than the center. And we found that the sulfur printing surface had dark brown Ag_2S dots spread throughout it.

References

❖ References :

- Notes during the lab
- YouTube videos
- Wikipedia
- The manual
- Diydata web

❖ Technology :

- AutoCAD
- Word