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Properties of Materials Laboratory

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Introduction and Objective:

Macroscopic Examination, also called Macro Examination, evaluates the quality and consistency of a test sample. Macroscopic means to investigate a workpiece over a comparatively large area, doing this only little or no magnification is required; often the naked eye sufficient to examine the material.

Using this technique, we can reveal defects and inhomogeneities over a broad area, it can also be used to find the size and distributions of non-metallic inclusions within the metal among other uses. Therefore, this technique is widely used in many stages of manufacturing processes to reach the desired level of quality.

In this experiment we are applying this method on Aluminum (Al) and steel to study the macrostructures of the metals and alloys; to discover the defects, impurities, flow lines, surface structure and grain size.

Materials and Equipment's:

1) Specimens of Aluminum and Steel.
2) Cutting Machine.

3) Grinding Machine.

4) Grinding paper grades of (120,180,240 and 400)

5) Mixture of Different Acids.
   for Aluminum we used the composition (15% HF, 35%HNO_3, 25%HCL and 25 H_2O) and for Steel we used (25% HNO_3, and 75%H2O).

6) Liquid (Water) used as a cooling liquid.

7) Specimen dryer.

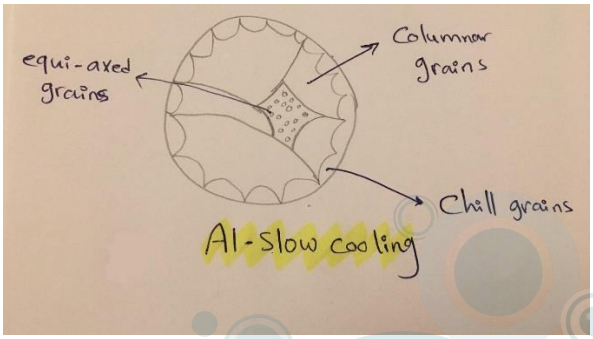
8) Silver bromide photographic papers.

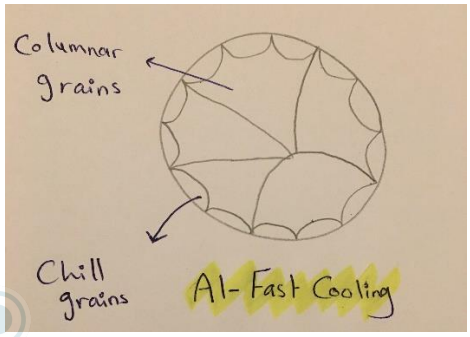
Experimental Procedure:

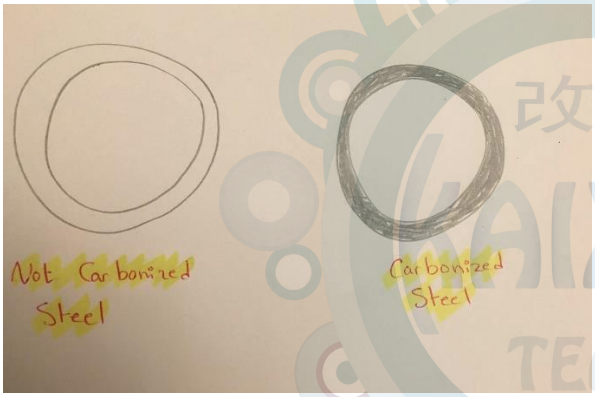
1) Select the specimen which we're concerned in this study (Al, Steel)
2) Cutting the specimen to achieve the wanted volume by using the cut-off machine, to avoid the overheating, we add water during the process.
3) Then we put the specimen in a suitable solvent to get rid of all the greases.
4) In order to obtain a soft smooth surface, we use grinding machine along with grinding paper with all its degrees (120,18,240 and 400) and when the grinding using the first paper is done, we rotate the specimen by 90 degrees, during the whole process the cooling fluid is a must.
5) Now we start etching the specimens using a proper solution, for Aluminum we used the composition (15% HF, 35%HNO_3, 25%HCL and 25 H_2O) and for Steel we used (25% HNO_3, and 75%H2O).
6) Leave the specimens for a few minutes then rinse them in water, after that rinse the specimen again but with alcohol to remove any traces of water.
7) Let the specimens dry in warm air blast
8) Sulfur printing: we use this technique to discover the Ag_2S, this is being accomplished by using the silver bromide photographic paper, sacked in a 2-5% H_2SO_4 for 3-4 minutes. And then drained to the surface of the sample for 1-2 minutes under moderately applied pressure, after that we remove the samples to obtain printings, these printings are gained through the following reactions:

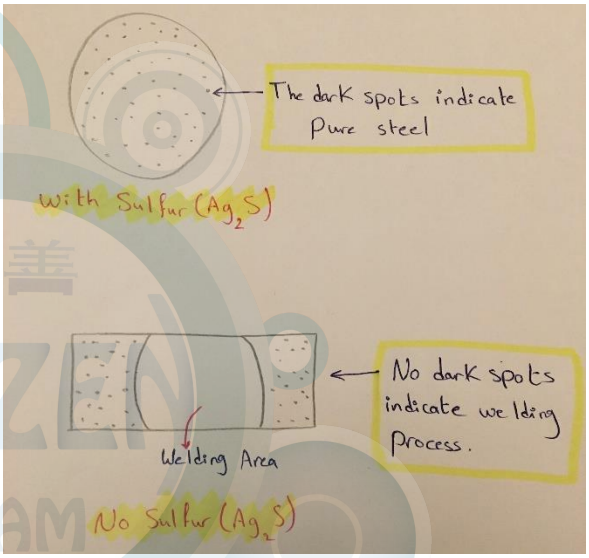
   FeS or $MnS + H_2SO_4 \dashrightarrow FeSO_4$ or $MnSO_4 + H_2S$
   Then
   $H_2S + 2AgBr \dashrightarrow Ag_2S + 2HBr$

Results:









Discussion:

We started the experiment by cutting Steel and Aluminum to obtain the specimens. Then, we placed the grinding paper on the grinding machine (120, 180, 240, 400) respectively.
We turned the machine on and opened the water tap that is connected to the machine before placing the specimen on the machine to avoid fractions that would lead to rising in temperature which would cause deformation in the material.
We changed the direction of the specimen 90 degrees every time we changed the grinding papers which were four times.
When we had a smooth surface, we turned the machine off. Afterwards, we prepared the etching solution (2-5% of H_2SO_4). We slowly immersed the specimen in the solution and then we etched it for a few minutes until we obtained the desired results.

Conclusions:

Throughout the experiment we conclude the following:

For Aluminum, the type of cooling used does significantly affect the existence of the equiaxed grains, from the experiment we conclude that using slow-cooling techniques will eventually leads to equiaxed grains, otherwise it won't.

In steel, we found that the edges were blacker than the center which indicates the carbonization process, also in sulfur printing we found some dark brown spots distribution of Ag_2S on the surface, we learned from this that having these spots gives us an indication for more brittle structure, however these spots weren't on the welding region.

In nutshell, we learned the properties of these metals and the defects that may appear on them.

References:

Experimental Laboratory Manual in Materials Science and Engineering

YouTube videos

Notes from the experiment

The metallurgical engineering team at Laboratory Testing Inc., near Philadelphia, PA (USA)