LAB MANUAL

METALLOGRAPHY II

Metallurgical Engineering Department

Orissa School of Mining Engineering

Keonjhar

Course code: Pr - 2

Semester – 5th

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List of Experiments

1. To prepare the Ferrous metal (mild steel) for metallography study
2. To prepare the sample and study the microstructure of Non-ferrous metal (Brass)
3. To study of micro-vicker hardness testing machine
4. Micro hardness of ferrous sample
5. ASTM grain size measurement of ferrous material by using quantimet software
6. To observe photomicrography of different ferrous and nonferrous material

EXPERIMENT – 1

AIM OF THE EXPERIMENT: -

To prepare the Ferrous metal (mild steel) for metallography study.

APPARATUS REQUIRED: -

1. Hacksaw blade
2. Ferrous metal (mild steel)
3. Bench grinder
4. Bench polisher
5. Filer
6. Double disc polisher
7. Emery paper [100, 220, 320, 420, 500, 600]
8. Etchant (Nital) [98%. ethyl Alcohol, (C_2H_5OH) +2%, Nitric Acid (HNO_3)

THEORY:-

Hacksaw Blade:-

- A hacksaw with a fine toothed blade can be used to out large sample. The blade can be periodically cooled in water to prevent excessive heating through friction.
- Mild steel -
- It contains approximately 0.05 - 0.25% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form, surface hardness can be increased through carburizing.

Bench Grinder:-

- A bench grinder is a tool that is generally use to form metal. A bench grinder generally has two grinding wheels, each of a various size. The function of a bench grinder is shaping and sharping metal tool. The output of a bench grinder is usually rough as they are not designed to offer smooth or accurate precision words.

Double Disc polisher :-

- It is a surface polishing equipment for smoothing a work piece surface using on abrasive and a work wheel.

Emery Paper:-

- It is used for mirror finish of the specimen six types of emery paper have been used in increasing order of fineness i.e. from 200 to 600.

Etching:-

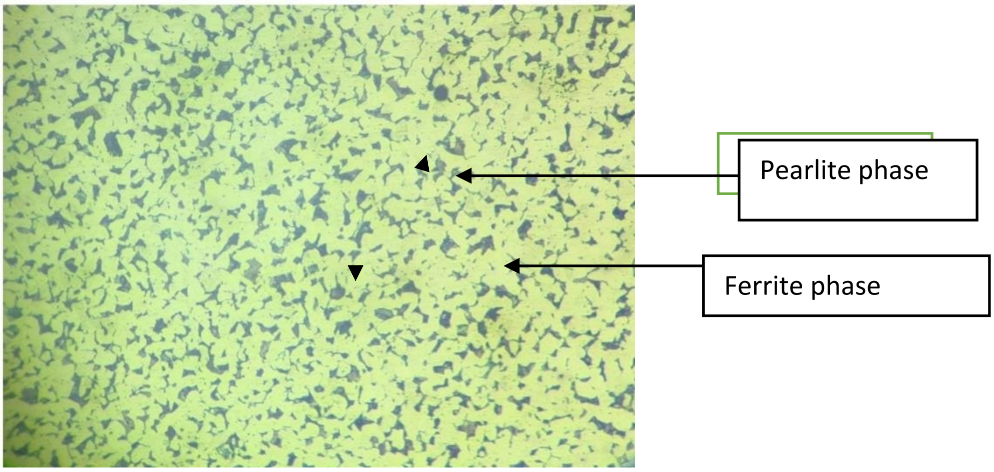
- Grains can not be seen in the microscope without etching, cracks, pores and defects are observed without etching. Etchant recasts with atoms and dissolves them. Atoms at grain boundries dissolve quickly. Dissolved grain boundries appear dark.

N.B

- Emery paper contains silicon carbide particles (Sic) 100 grit number emery paper means 100 number of sharp Silicon carbide particles present in 1-inch square area.

PROCEDURE:-

a) Mild steel sample was taken after cutting it with power hacksaw to get proper sample size.
b) Rough polishing was done by using filer.
c) Next stage of file polishing was done using emery paper.
d) Starting from grit number 100, 220, 320, 400, 500, then 6OO grit number paper we are used for fine polishing.
e) After polishing by 6oo grit number emery paper the sample was taken for smooth polishing.
f) Smooth /cloth polishing was done using double disc Polisher.
g) Next etching was done using nital . A cotton was dipped in the nital solution and was rubbed on the surface of specimen.
h) After 5-10 seconds. It was washed with water and dried using dryer.
i) Then the specimen was placed on the mounting place of inverted digital microscope.
j) Coarse and fine knob was adjusted to see the microstructure.
k) Microstructure was taken magnification of 400x.
l) Photomicrography of the specimen was saved in the computer.



[MICROSTRUCTURE OF FERROUS METAL (MILD STEEL) AT 400X MAGNIFICATION]

CONCLUSION: -

The microstructure of mild steel was studied and it was found out that the microstructure contains pearlite phase (black colour) surrounded by ferrite matrix (White colour).

EXPERIMENT – 2

Aim of the experiment:-

To prepare the sample and study the microstructure of Non-ferrous metal (Brass).

Apparatus Required:-

1. Non-ferrous metal (Brass)
2. Hacksaw blade
3. Filer
4. Emery paper
5. Etchant ($FeCl_3$ – 48%, Water – 50%, conc. HCl- 2%)
6. Metallurgical microscope (Digital version)

Theory:-

Brass-

- Brass is a metallic alloy that is made up of copper and zinc. The proportion of zinc and copper can very to create different types of brass alloys with varying mechanical and electrical properties.
- It is used for decoration for its bright gold Like appearance
- For applications where low friction is required such as Locks, gears, Bearing etc.

Types of Brass:-

α - alloy (up to 35% Zn) - single phase

- cold working alloys.

α+βalloy (35-40% Zn) - Two phase (duplex brasses)

- Hot working alloys.

α- Alloys:-

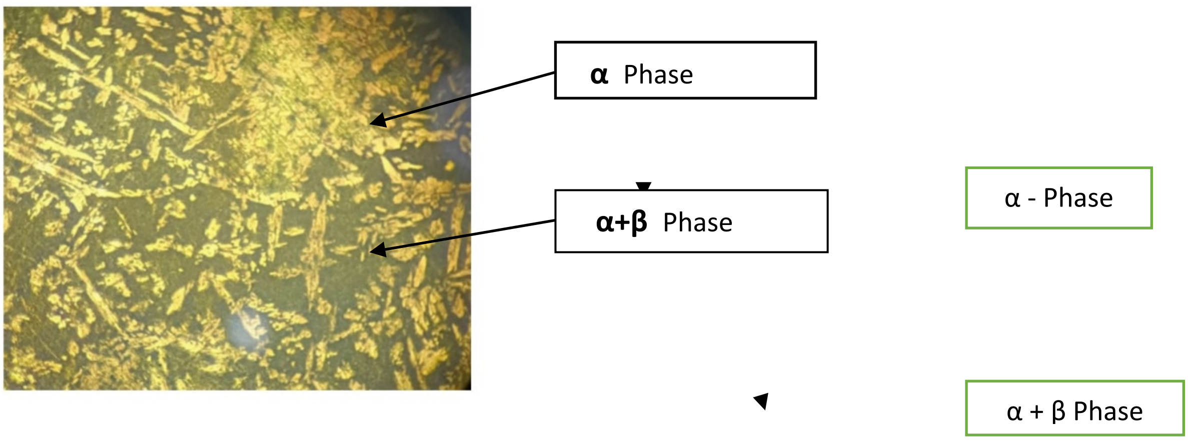
- Brasses containing a minimum of 63% cu are termed alpha brasses or cold working brasses.
- They are highly ductile at room temperature and are readily deformed by cold rolling, bending, thread rolling etc.
- Alloys with a higher copper content (80 - 90%) and which are gold in colour are used extensively for decorative metalwork, costume Jewellery etc.

α+β Alloys:-

- Brasses containing 35 – 40% Zn are known as α+β or duplex brasses because they contain a mixture of the original solid solution (α- phase) and a new solid solution of higher Zn content (β-phase).
- Their ability to be deformed at room temperature (cold worked) is Limited.
- They are ideal for extruding into complex solid and hollow shapes and not forging.

Procedure:-

1. Brass sample was taken after cutting it with power hacksaw to get proper sample size.
2. Rough polishing was done by using filer.
3. Next stage of fine polishing was done using emery paper.
4. Starting from grit number 220, 320, 400, 500 then 600 grit number paper are used for fine polishing.
5. After polishing by 600 grit number emery paper the sample was taken for smooth polishing.
6. Smooth / cloth polishing was done using double disc polisher.
7. Next etching was done using $FeCl_3$, conc. HCl and H_2O. A cotton was dipped in this solution and was rubbed on the surface of specimen. After 5-10 second it was washed with water and dried.
8. Then the specimen was placed on the mounting place of inverted metallurgical microscope.
9. Coarse and fine knob was adjusted to see the microstructure.
10. Microstructure was taken at magnification of 400x.
11. Photomicrography of the specimen was saved in the computer.



[MICROSTRUCTURE OF BRASS AT 400X MAGNIFICATION]

CONCLUSION: -

The brass microstructure was studied and the phase in the microstructure were α- phase (white) and α+β phase (dark).

EXPERIMENT - 3

Aim of the Experiment: -

To study of micro-vicker hardness testing machine.

Apparatus required: -

- ❖ Micro-vicker hardness testing machine.

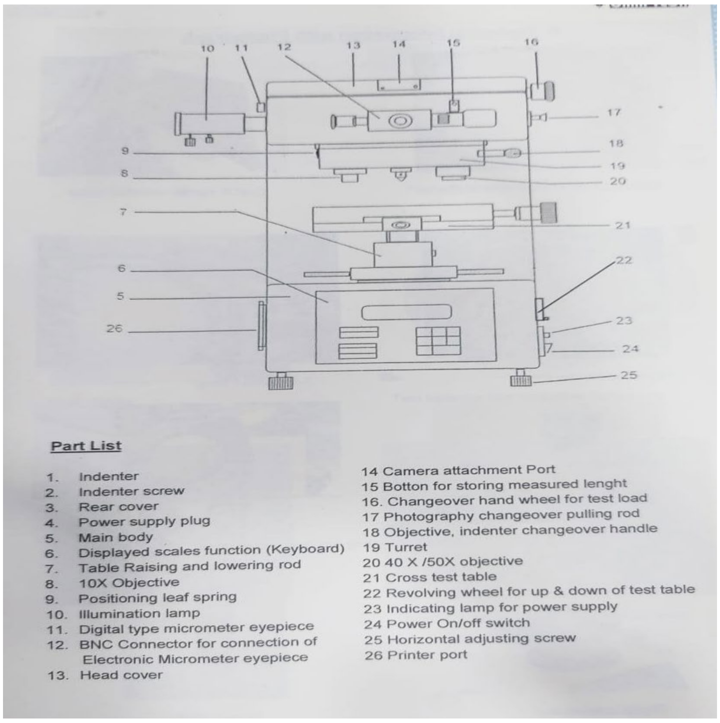
Theory: -

- ➢ The terms microhardness test usually refers to static indentation made with loads not exceeding 1 Kgf.
- ➢ The indenter is either the vicker diamond pyramid on the knoop elongated diamond pyramid.
- ➢ The procedure for testing is very similar to that of the standard vicker hardness test except that is done in a microscopic scale with higher precision instruments.

Parts: -

Diamond indenters:

- ➢ The diamond indenter and the indenter shaft are the very important part of the apparatus hence in the course of operation.
- ➢ Do not touch indenter used holder.
- ➢ In order to ensure the measuring precision the indenter shay be kept clean, when it is can't contaminated by oil dirts or dust dip the alcohol (for industrial use) or either with cotton and carefully & lightly rub at the indenter tip to make it clean.



Micrometer Eyepiece: -

- Due to the visual difference existed in different persons, the calibrated line Observed in the visual field of the eyepiece may be dim. Therefore, when the observer is changed to another persons, it shall be first to make fine tune - up by rotating the eyepiece lens, So as to make the internal side of the calibrated line observed in the visual field is distinct.
- Insert the micro-meter eyepiece into the tube of eyepiece, when measuring the diagonal of the indentation by turning the eyepiece 90^0 noted that the micro-meter eyepiece shall be closely adhered to the eyepiece tube, and it is prohibited to leave any gap, else it will affect the impression of measurement.

Specimen:-

- When the specimen are fine wire, thin sheets ore small pieces, they may be respectively clamped in the fine wire holder, thin sheet holder or flat and holder, after that put them again on the cross test table to carry out the test if the test piece is too small to be
- The specimen should be free from that oil, dirt etc.

PROCEDURE:-

1. Switch on the power switch and light source.
2. The changeover hand wheel on the test load indicating the test load.
3. Rotate the changeover hand wheel on the text load. Until the test Load meets the selected requirement select required load by change, over knob carefully and slowly to prevent weight from impacting against each other.
4. The LCD screen will display the D1, D2, HV/HK time and load etc.
5. Rotate the changeover handle of the objective lens the indenters and keep the 40x objective lens at the front position of the main body.
6. Put the specimen on the test table and rotate the revolving wheel to make the test table Lifting upward. Observe the micro-meter eyepiece closely by eyes.
7. When the specimen. are 2-3 mm apart from the Lower end of the objective lens at the centre of the visual field of the eyepiece will appear a bright flare
8. Which expresses that the focusing will come soon, at this time, it shall be lifted up slowly in micro quantity untill a distinct image formed at the surface of the specimen is observed in the Eyepiece
9. When the focusing process is completed
10. if the image observed in the eyepiece present in a dim state or semi-distinct, it means that the centre of light source deviates from the central optical path system, and it is necessary to adjust the central optical path system, and it is necessary to adjust the central optical of the lamp
11. In case the visual field is too dark or too bright, the strong or weak light source may be adjusted.
12. If it intends to observe a large range visual field on the handle of the objective indenter counter-clock-wisely to the front part of the main body, at this time, the total amplifying magnification the optical system will be 100x which is in the state of observation

13. Turn the changeover handle counter-clock wisely and make the main shaft of the indenter in the front of the main body, at this time, then the gap between the indenter tip & the specimen is measured be careful to prevent the indenter
14. Based upon requirement of test, key in the delayed load holding time of the test load on the Key board.
15. For most ferrous & non-ferrous hardness testing dwell time setting 10-15sec
16. For very soft material longer dwell time 25 to 30sec
17. Press the start key on the key pad then the test load the light up
18. After completing the exertion of the test load, the Dwell time LED light up at this time T on the LED screen will according to the numbers of time elapsed counter clock-wisely.
19. When the delayed time arrives then test load is unloaded and the unloading test load LED lights up.
20. Turn the changeover handle clock wisely and make the 400x objective lens in the front part of the main body. Then is measured, the diagonal length from the micro-meter eyepiece.
21. Before measurement first turn clock wisely the drum wheel on the right side of micro-meter eyepiece so as to make the two calibrated lines observe in the eyepiece moving mutually closely.
22. When the edges of two calibrated lines draw closely.
23. Then the press the 'clr' key to clear to zero at display of 'D1'.
24. First turn the left side drum wheel and make the calibration line to one corner of the Indentation. Next turn the right side drum wheel, then the two calibration lines are separated.
25. Make the right side calibration line align to the another corner of the indentation.
26. Press the bottom of the lower part of the micro-meter eyepiece, it will display 'D1' on the display screen.
27. After the result has been input the curser turn to 'D2' then measure & determine the length of another diagonal again.
28. At this time the HV hardness value on the LCD screen will be displayed automatically.
29. After completing the measurement, then you may start the next test, or press, the 'RESET' to restart the test.

Indentation:-

- ✓ Bring the measurement Lines & indentation into the field of view focus indentation sharply.
- ✓ Adjustment of calibration line.
- ✓ First turn the left side knob of measuring microscope and adjust the inside edge of the lift measuring line precisely to the point of the indentation.

Conclusion:-

Hence, studied of micro-vicker hardness testing machine has been successfully done.

EXPERIMENT-4

AIM OF THE EXPERIMENT

Micro hardness testing of ferrous sample .

APPARATUS REQUIRED

a) Ferrous sample (mild steel)
b) Power hacksaw
c) Bench grinder
d) Emery paper
e) Double disc polisher
f) Etchant (Nital solution)
g) Dryer
h) Micro vicker hardness testing machine

THEORY

Micro hardness test

Micro vicker hardness test uses a square based diamond pyramid as an indenter. the included angle between opposite faces is 136^o. this angle was chosen because it approximate the most desirable ratio of indention diameter to the indenter diameter. the diamond pyramid hardness number (DPHN) or VHN is defined as the load divided by the surface area of the indentation.

The hardness of the samples will be measure by

$VHN = \sin^{\theta}/2/l^2$

$= 1.854P/l^2$

where P= applied load in kg

L= average length of diagonal, mm

$^{\theta}$= angle between opposite faces of diamond indenter 136^o

PROCEDURE

1. The sample was cut into small pieces so that polishing could be done easily in bench grinder.
2. Power hacksaw used for cutting.
3. Sample was ground till a flat surface was obtained so that polishing could be done.
4. Next stage of fine polishing was done by using emery paper.
5. This will provide the sample a bright and polished surface.
6. After paper polishing the sample is then subjected to disc polishing or cloth polishing by using alumina water solution.
7. After all the polishing processes the sample is etched for 7-10 sec with freshly prepared nital solution (HNO_3 =2% ,C_2H_5OH = 98%) .
8. The micro vicker hardness test will be conducted for measuring the hardness of mild steel.
9. The square based diamond pyramid as indenter and 1000gm force load applied for 10sec(dwell time).
10. After unloading the values of diagonals of the indentations D1 and D2, the calibrated the diagonal values in the screen and the hardness value automatically shown on the screen.

11. The hardness value will be measured in 3 locations over the sample and the average length of diagonals of the indentation will be calculated and tabulated.

CONCLUSION

The microhardness testing was done. The Vickers hardness number of mild steel sample was…….. .

EXPERIMENT-5

AIM OF THE EXPERIMENT

ASTM grain size measurement of ferrous material by using Quantimet software.

APPARATUS REQUIRED

a) Ferrous sample (mild steel)
b) Power hacksaw
c) Bench grinder
d) Emery paper
e) Double disc polisher
f) Etchant (nital solution)
g) Dryer
h) Metallurgical microscope
i) Desktop (quantimet software)

THEORY

INTERCEPT METHOD

- ✔ In this method a standardized length of a line is calculated using quantimet software.
- ✔ After this, ten horizontal lines were drawn on the image of the microstructure.
- ✔ Then number of intercepts were calculated individually that a line is cutting the grains of the microstructure.
- ✔ Then the standardized length of the line was divided by the number of intercepts obtained individually and an average grain size was calculated for horizontal direction.

PROCEDURE

Sectioning

Sectioning means removal of convenient size specimen from large sample with minimal damage to microstructure with the help of abrasive cut off machine. Abrasive cutting wheel/saw is attached to cutting machine and for work piece holding proper vice is provided on machine. The primary concern in this process is to minimize the heating of the sample due to the cutting. For this reason, the cut-off saws that is equipped with either water-cooling system.

Sample Surface Polishing

The goal of the surface polishing is to end up with a planar cross section of sample free from scratches or disturbed metal introduced by the cutting and sectioning. This process is a step-wise process that can be broken into three loosely separate parts: grinding, coarse polishing, and final polishing.

Grinding

The first step in preparing your sample is to ensure that you have a flat surface to begin with. A water-cooled abrasive grinder is available to form a flat initial surface from which to begin. After getting a flat sample on the belt grinder, WASH sample thoroughly. The hand lapping station has four graded abrasive papers to produce a sequentially finer surface finish. Be sure the water is turned on and flowing uniformly over the abrasives. Start with the coarsest grit (240) and, using a firm and uniform pressure, slowly move the specimen forward and back across the abrasive. This will produce parallel scratches of uniform size. Continue this step until the entire surface of your sample is flat and contains only scratches of the size of 240 grit abrasive. When the sample is flat and the only scratches remaining are those due to the 240 grit abrasive, WASH your sample and your hands thoroughly, and move to the 320 grit abrasive. Repeat this procedure for the 400 grit and the 600 grit abrasive, checking after each step to be sure that only those scratches remain that are due to the smallest grit.

Rough Grinding

Before proceeding to the first polishing wheel (leftmost wheel), wash sample with water.

1) First, apply a small amount of water to the wheel, turn on the motor, and gently clean off the wheel with your fingers.
2) Apply a small amount of abrasive slurry to the wheel. This wheel uses an AI203 abrasive in a water suspension. The abrasive particles are 5 micrometres in diameter.
3) Carefully place your sample on the wheel while gripping it tightly. Slowly move the sample in a circular motion against the rotation of the wheel. Use a moderate and even pressure. It is important to ensure that you keep the sample flat on the wheel so that the final surface will be completely planar.
4) After several minutes on the wheel, hold the sample in one place for a moment. This will provide lots of parallel scratches that you can use to determine if you have removed the damage from the grinding steps.
5) Examine the sample under the microscope to determine if all the scratches are the same size.
6) Repeat steps 1-5 on the middle polishing wheel. This wheel uses a 0.3 micrometre A1203 abrasive in a water suspension.

Final Polishing

1) Repeat steps 1-5 above on the right polishing wheel. This wheel uses a 0.05 micrometre A1203 abrasive in a water suspension. At this point, the sample will be very smooth to the eye and even the oils and dirt on your fingers will scratch it with larger scratches than the abrasive. DO NOT TOUCH THE SAMPLE SURFACE FROM THIS POINT ON.
2) The last step in the process is to etch the sample to bring out the microstructure.

3) Use a cotton swab and a petri dish for the etching. Gently swab the surface of your sample with the etchant. Roughly spreading the etchant will scratch your surface. Let the etchant stand for 15 seconds or so and rinse the sample with water to stop the etching, and rinse again with methanol. Rinse the swab with water and throw into the trash bin.

4) Examine specimen under the microscope. You may require several etching steps to bring out the microstructure.

5) If the sample is over-etched, repeat the final polishing step and re-etch for a shorter time. Samples to be examined at high magnification generally require shorter etching times than those to be viewed at lower magnifications.
After last polishing stage the sample looks mirror like.

Etching

Grains cannot be seen without etching. Cracks, pores and defects are observed without etching. Etchant reacts with atoms and dissolves them. Atoms at grain boundaries dissolve quickly. Dissolved grain boundaries appear dark.
Steps: 1) Apply enchant to polished surface for some time

1) Rinse with distilled water
Etching was done using nital solution (HNO_3 =2%, C_2H_5OH = 98%).

IMAGE LOADING

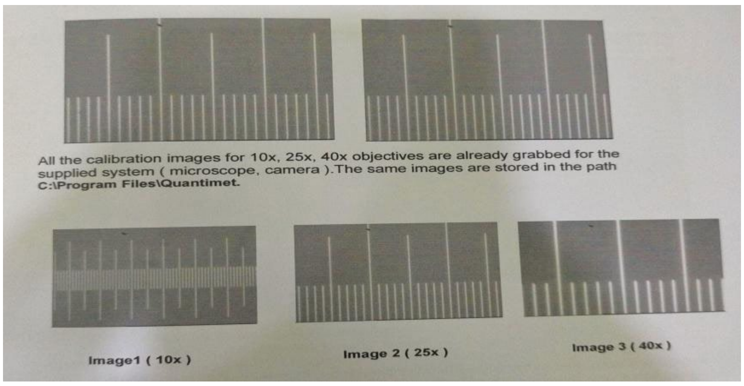
- ✔ After observing the microstructure of the sample average grain size was determined by intercept method using Quantimet software.
- ✔ Load the image for grain size measurement.

CALIBRATION SYSTEM

Before going ahead for image analysis one has to calibrate entire system like microscope-computer with the help of calibrated (traceable) object micrometer slide (1 mm/100 parts).For calibration subject the slide image, then click on two lines of the image as shown. The following dialogue box appears that shows the number of pixels between the two lines, one has to fill actual distance between the two lines with corresponding magnification.

Important - Before going for analysis of any grabbed image, Click Calibration on the main menu or make sure that the system is calibrated on the same magnification on which the image is grabbed.

In the status bar of the Main Form you will get the current calibration of the system with the X,Y co-ordinate and Gray value of the current pixel under the mouse pointer(only over the image) as shown below.



After clicking Calibration on the main menu you will get the following shown form Select the magnification on which you want to calibrate the system (eg. 10X, 25X, 40X) New Calibration option is given to calibrate the system on other than the given magnifications.

After selection of magnification option you will get the Cross mouse cursor over the Place the cursor as shown in the above image. The Least count of the given calibration scale is 10µm.

Place the cursor on any two lines on the image, the computer will show you the distance in pixels (55 in above figure), you have to feed the actual distance in the SECOND BOX according to line you have placed on the image.

Calculate the actual distance from following Formula.

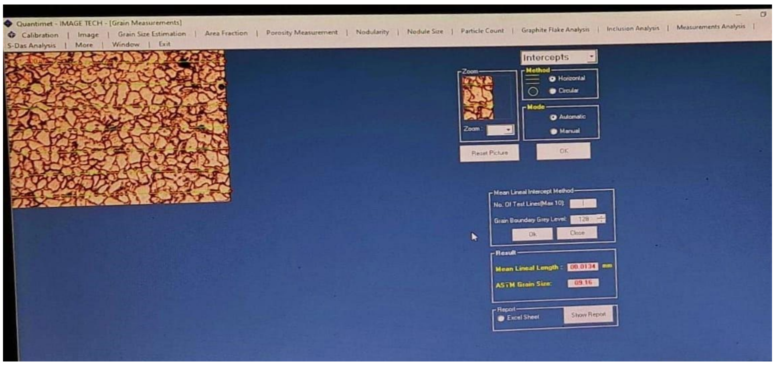
Actual Distance (in um.) = (No. of Lines Between Green Lines you placed) * 10µm.

GRAIN SIZE MEASUREMENTS

This module determines the grain size by: -

Intercept Method

1)Load the image for Grain size measurement and click Grainsize Measurement on the menu bar. Following window appears.



2) Select any of the two Horizontal or Circular in Select Intercept Frame. And Automatic and Manual in Select Mode Frame. Then click OK. You will get following window with dialog box for Number of test lines and Grain boundary gray level.

Automatic Method:

Fill the number of lines and gray value of grain boundaries. After pressing the button OK, you can get the result as shown. The software automatically detects grain boundaries and plot the points wherever line intercepts with grain boundaries. Mean Lineal Intercept and ASTM Grain size No. will be calculated and displayed. Note: Number of test lines should not be more than ten.

Manual Method:

In this method it will ask you for the number of test lines only. After clicking 'OK' the given number of lines will appear on the image. The user has to plot the points over the grain boundaries and test line intercepts. Click Result button to get the Mean Lineal Intercept and ASTM Grain size no.

CONCLUSION:-

ASTM grain size number of mild steel was found.

EXPERIMENT -6

AIM OF THE EXPERIMENT

To observe photomicrography of different ferrous and nonferrous material.

APPARATUS REQUIRED

1. Hacksaw blade
2. Ferrous metal (mild steel, cast iron, stainless steel)
3. Nonferrous metal (aluminium, brass, copper)
4. Bench grinder
5. Bench polisher
6. Filer
7. Double disc polisher
8. Emery paper [100, 220, 320, 420, 500, 600]
9. Etchant for ferrous specimen (Nital) [98%. ethyl Alcohol, (C_2H_5OH) +2%, Nitric Acid (HNO_3)
10. Etchant ($FeCl_3$ – 48%, Water – 50%, conc. HCl- 2%)
11. Alumina powder
12. Brasso
13. Metallurgical microscope

THEORY

STAINLESS STEEL

- Stainless steel contain typically 12-30% chromium with or without other alloying element.
- Chromium imparts corrosion resistance to steel.
- Types of stainless steel

Austenitic stainless steels: which contain 18% Cr, 8% Ni, and C is in between 0.03-0.15%

Ferritic stainless steels: which contain 12% to 30% Cr and 0.08% to 0.12%C.

Martensitic stainless steels: which contain around 13% Cr and C varying in between 0.15% to 0.25%. Certain grades contain C 0.6% to 0.95%.

PROPERTIES

- Better corrosion resistance
- High strength
- High ductility

Cast irons typically contain 2-4 wt.% of carbon with a high silicon concentration and a greater concentration of impurities than steels.

Types of cast iron

- Grey cast iron
- White cast iron
- Malleable cast iron
- Ductile cast iron

PROPERTIES

- Hardness
- Machinability – easily machined to a good finish
- Self damping does not vibrate

MILD STEEL

- It contain 0.15-0.35% C.
- Mild steel has a relatively low tensile strength
- It is cheap and easy to form, surface hardness can be increased through carburising

PROPERTIES

- High tensile strength
- Good ductility and weldability
- Good malleability

BRASS

- Brass is a metallic alloy that is made up of copper and zinc.
- The proportion of zinc and copper can very to create different types of brass alloys with varying mechanical and electrical properties.
- It is used for decoration for its bright gold Like appearance
- For applications where low friction is required such as Locks, gears, bearing etc.

Types of Brass:-

α - alloy (up to 35% Zn) - single phase

- cold working alloys.

α+β alloy (35-40% Zn) - Two phase (duplex brasses)

- Hot working alloys.

α- Alloys:-

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- They are highly ductile at room temperature and are readily deformed by cold rolling, bending, thread rolling etc.
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α+β Alloys:-

- Brasses containing 35 – 40% Zn are known as α+β or duplex brasses because they contain a mixture of the original solid solution (α- phase) and a new solid solution of higher Zn content (β-phase).
- Their ability to be deformed at room temperature (cold worked) is Limited.
- They are ideal for extruding into complex solid and hollow shapes and not forging.

PROPERTIES

- Malleability and formability
- Non ferromagnetic

ALUMINIUM

- Aluminium has low density than other metals
- It has great affinity towards oxygen and form a protective layer of oxide on the surface when exposed to air.

PROPERTIES

- It has low density
- High thermal conductivity
- It has excellent resistance to corrosion
- It is non toxic

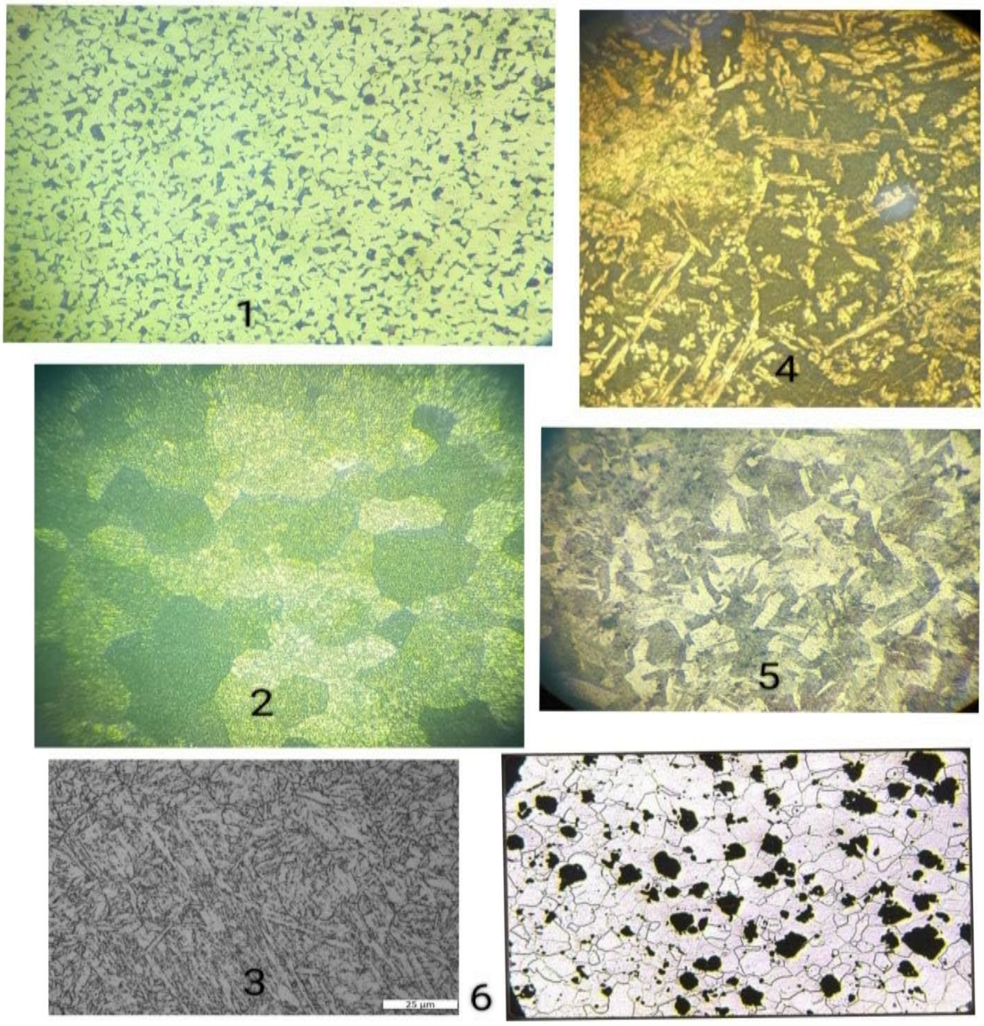
COPPER

- It is a soft malleable and ductile metal with high thermal & electrical conductivity.
- Copper is used as a conductor of heat and electricity
- It is used to make marine hardware and coins.

PROCEDURE:-

1. All ferrous and nonferrous sample was taken after cutting by power hacksaw to get proper size.
2. For both ferrous and nonferrous rough polishing was done by using bench grinder.
3. Next stage for fine polishing was done using emery paper.
4. Starting from grit number 100, 220, 320,400, 500 then 600 grit number.
5. After polishing by 600 grit number emery paper the sample was taken for smooth polishing.
6. For ferrous material smooth polishing was done by using alumina with water solution.
7. For nonferrous material smooth polishing was done by using brasso.
8. Then etching was done.
9. For ferrous material the etching was done using Nital solution .
10. For nonferrous material etching was done using ($FeCl_3$ – 48%, Water – 50%, conc. HCl- 2%).
11. The cotton was dipped in etchant and rubbed on the surface of specimen.
12. After 5-10 sec it was washed with water and dried using dryer.
13. Then the both ferrous and nonferrous samples were placed under inverted digital microscope.
14. Coarse and fine knob was adjusted to see the microstructure.
15. Microstructure were taken at magnification of 400x.
16. Photomicrography of the specimen were saved in the computer.

OBSERVATION:-



Microstructure of 1. Mild steel 2. Aluminium 3. stainless steel 4. Brass 5. Copper 6. Malleable cast iron

CONCLUSION:-

- Both ferrous and nonferrous samples microstructure were observed.
- The microstructure of mild steel contain pearlite phase surrounded by ferrite matrix.
- The microstructure of malleable cast iron showing ferrite matrix and tempered carbon.
- The microstructure of stainless steel showing ferrite and austenite.
- The microstructure of brass showing **α** phase(white)and **α+β** phase (dark).
- The copper and aluminium microstructure showing single **α** phase.