SRI VENKATESWARA COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS)

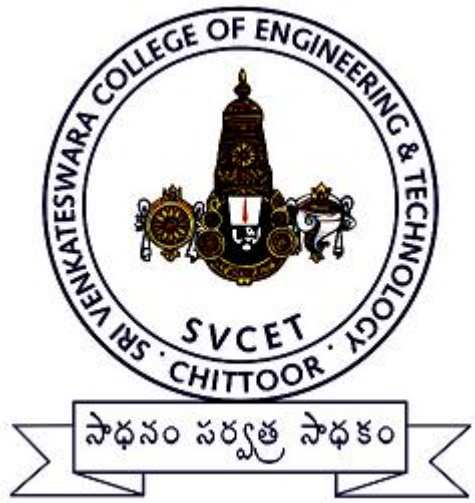
R. V. S. Nagar, Chittoor. A.P-517127.

Accredited by National Board of Accreditation. New Delhi

Approved by AICTE, New Delhi, affiliated to J.N.T.U Ananthapur

An ISO 9001:2000 Certified Institution

DEPARTMENT OFMECHANICALENGINEERING



ENGINEERING MATERIALS LAB MANUAL

Name: ……...

Roll number:…….. Section: …….

Year: ……Semester: ……..

SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)
R.V.S. NAGAR, CHITTOOR-517 127, ANDHRA PRADESH
DEPARTMENT OF MECHANICAL ENGEERING

Vision of Mechanical Engineering

Providing excellent technical education in Mechanical Engineering with the help of state of art infrastructure and carvethe youth to suit the global needs.

Mission of Mechanical Engineering

Provide excellent Teaching-Learning process using state of art facilities to help a holistic growth in the disciplines of Thermal, Design, Manufacturing, Management and Quality areas with an emphasis on practical applications. Stimulate innovative thinkingleading to higher learning.

SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF MECHANICAL ENGINEERING

Programme Educational Objectives (PEO's) of UG:

PEO1	Pursue higher education in the varied fields of mechanical engineering and management.
PEO2	Secure a career placement in core and allied areas
PEO3	Develop skills to undertake entrepreneurship and lifelong learning

PROGRAMME SPECIFIC OUTCOMES (PSOs) of UG

PSO1	Apply the knowledge of manufacturing, thermal and industrial engineering to formulate, analyze and provide solutions to the problems related to mechanical systems
PSO2	Apply the design concepts and modern engineering software tools to model mechanical systems in various fields such as machine elements, thermal, manufacturing, industrial and inter-disciplinary fields.

SRI VENKATESWARA COLLEGE OF ENGINEERING & TECHNOLOGY

[AUTONOMOUS]

DEPARTMENT OF MECHANICAL ENGINEERING

DO'S

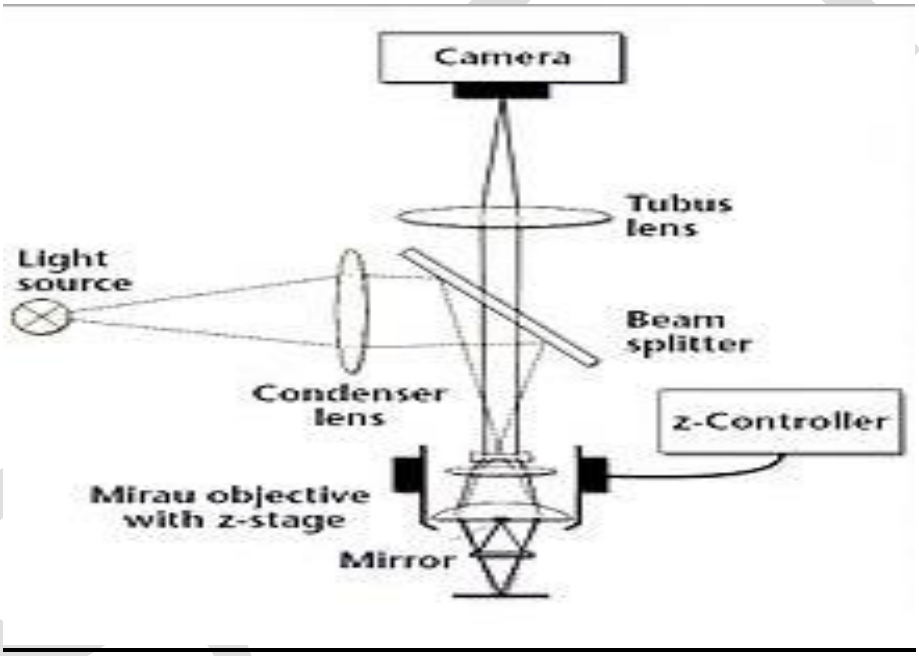
- Wear uniform, shoes & safety glasses
- Please follow instructions precisely as instructed by your supervisor.
- If any part of the equipment fails while being used, report it immediately to your supervisor.
- Students should come with thorough preparation for the experiment to be conducted.
- Students will not be permitted to attend the laboratory unless they bring the practical recordfully completed in all respects pertaining to the experiment conducted in the previous class.
- All the calculations should be made in the observation book. Specimen calculations for oneset of readings have to be shown in the practical record.
- Wherever graphs are to be drawn, A-4 size graphs only should be used and the same shouldbe firmly attached to the practical record.
- Practical record should be neatly maintained.
- Students should obtain the signature of the staff-in-charge in the observation book aftercompleting each experiment.
- Theory regarding each experiment should be written in the practical record before procedurein your own words.

DONT'S

- Do not touch hot work piece
- Do not start the experiment unless your setup is verified & approved by your supervisor.
- Do not leave the experiments unattended while in progress.
- Do not crowd around the equipment's & run inside the laboratory.
- Don't wear rings, watches, bracelets or other jewellery
- Don't wear neck ties or loose turn clothing of any kind.
- Do not eat or drink inside labs.
- Do not wander around the lab and distract other students
- Do not use any machine that smokes, sparks, or appears defective

INDEX				
S.No	**Name of the Experiment**	**Page No**	**DATE OF Exp.**	**Signature of the Faculty**

STUDY OF METALLURGICAL MICROSCOPE


Camera
Tubus lens
Light source
Beam splitter
Condenser lens
z-Controller
Mirau objective with z-stage
Mirror

STUDY OF METALLURGICAL MICROSCOPE

Aim: - Study of Metallurgical Microscope.

Introduction: - The metallurgical microscope is the most important tool of the metallurgist. It consists an objective and an eye-piece. Its primary function is to reveal the details of the object. The clarity and the extent to which the details are revealed depends on the degree to which these optical systems are created.

Principle: - A horizontal beam of light from the light source is reflected by means of a plane glass reflector downwards through the microscope objective on the surface of the specimen some of these incident light reflected from the specimen surface will be magnified and passing through the plane glass reflector and magnified again by upper lens system of the eye-piece.

Constructional Details: - The table type microscopes are consisting of

1. **Stage**: - A flat movable table supporting specimen. This can be moved up ordown by knobs.

2. **Tubes: -** The vertically movable tube containing eyepiece, objective and plane reflector. The tube length varies from 160 mm to 250 mm.

3. **Rough & fine focus Adjustments -** The limbs of microscope carry the coarse& fine adjustments to facilitate the

4. **Objective:**– The body tube carries revolving nose piece carrying the three objectives. This enables quick change of the objective which helps for a quick resolving the structure of metal, the magnification of lenses is enlarged on focal length of the lens used.

The important properties of an objective are-

1) Magnifying Power

2) Resolving Power

It is the property by which an objective shows distinctly represented two small adjacent bonds in the structure of the object. This is usually expressed as number of lines per mm that can be separated which depends on the numerical operator, the wavelength of the

light used. Resolution is particularly important during the microscopy of the micro constituents of metals consisting of fine lamination with core resolution which appears as one uniform area, where as an objective with higher numerical appearance reveals deeper nature of the structure.

5. **Eyepiece** - It is named, as it is near to the eye. It is made up of various Powers such as x 5, x 10, x15 etc.

Uses – The metallurgical microscope is useful in quality control department in Industries to observe & study

1) Differential phases 2) Porosity or defects.

All these have a great effect on mechanical properties of material

List of Modern Microscopes –

i) Watson Royal Microscope.

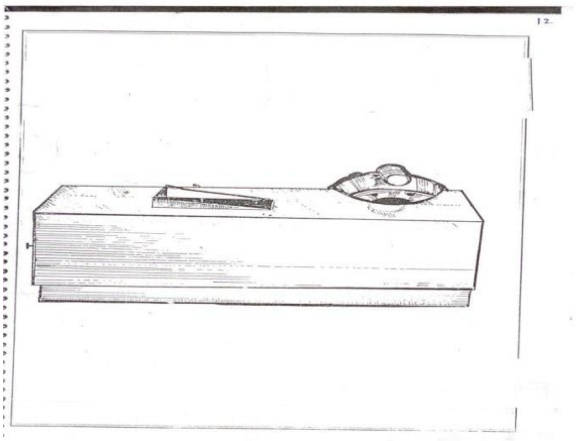
ii) Van Lanes Hock Microscope.

iii) Glass led Microscope.

iv)Baker series Microscope.

v) Leitr Microscope.

SPECIMEN FOR METALLOGRAPHIC EXAMINATION



BELT GRINDING MACHINE

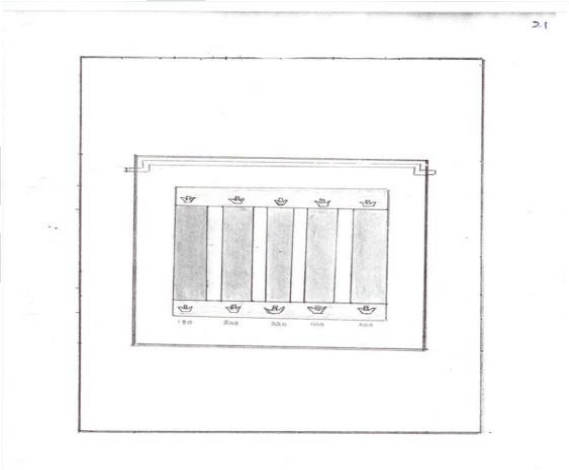
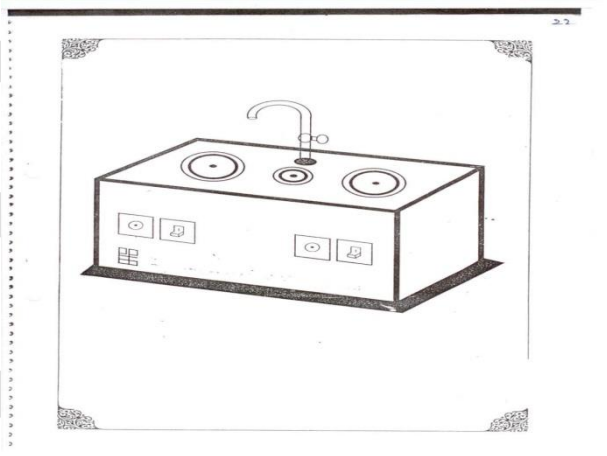


PLATE POLISHING MACHINE



DISC POLISHING MACHINE

SPECIMEN FOR METALLOGRAPHIC EXAMINATION

Aim: – Preparation of a Specimen for metallographic examination.

Introduction:– Metallographic or microscopy consists of the microscopic study of the Structural characteristics of material or an alloy. The microscope is thus the most important tool of a metallurgist from both, scientific & technical study point view. It is possible to determine grain size & the size, shape & distribution of various phases & inclusions which have a great effect on the mechanical properties of metal. The microstructure will reveal the mechanical & thermal treatment of the metal & it may be possible to predict its behavior under a given set of conditions.

Experience had indicated the success in microscopic study depends upon the case taken in the preparation of specimen. The most expensive microscope will not reveal the structure of a specimen that has been poorly revealed. The procedure to be followed in the preparation of a specimen is comparatively similar and simple & involves a technique which is developed only after constant practice. The ultimate objective is to produce a flat, scratch free, mirror like surface. The steps involved or required to prepare a metallographic specimen properly are covered in the coming section explained below.

Sampling:– The choice of sample for microscopic study may be very important. If a failure is to be investigated the sampling should be chosen as close as possible to the area of the failure & should be compared with one taken from the normal section. If the material is soft, such as non-ferrous metals or alloy & non heat-treated steels, the section is obtained by manual hack sawing /power saw. If the material is hard, the section may be obtained by use of an abrasive cut off wheels. This wheel is thin disk of suitable cutting abrasive rotating at high speed. The specimen should be kept cool during the cutting operation.

Rough Grinding: – Whenever possible the specimen should be of a size & shape that is convenient to handle. A soft sample may be made flat by slowly moving it up to & back across the surface of a flat smooth file. The soft hard may be rough ground on a belt sander with specimen kept cool by frequent dipping in water during the grinding operation. In all grinding & polishing operation, the specimen should be moved perpendicular to the existing scratches this will facilitate, recognition of stage when the deeper scratches are replaced by

shallower one characteristic of the finer abrasives. The rough grinding is continued until the surface is flat & free from wire brushes & all scratches due to hacksaw or cutoff wheel are no longer visible.

Intermediate Polishing:– After the previous processes the specimen is polishing on a series of emery paper containing successively finer abrasive (Si-C). The first paper is usually no. 1 than 1/ 0, 2/0, 3/0, & finally 4/0. The intermediate polishing operation using emery paper is usually done dry. However, in certain case such as preparation of soft material, Silicon Carbide has greater removal rate & as it is resin bonded, can be used with a lubricant, which prevents overshooting of the sample, minimizes shearing of soft metals & also provides a rising action to flush away surface removal product so the paper will not be clogged.

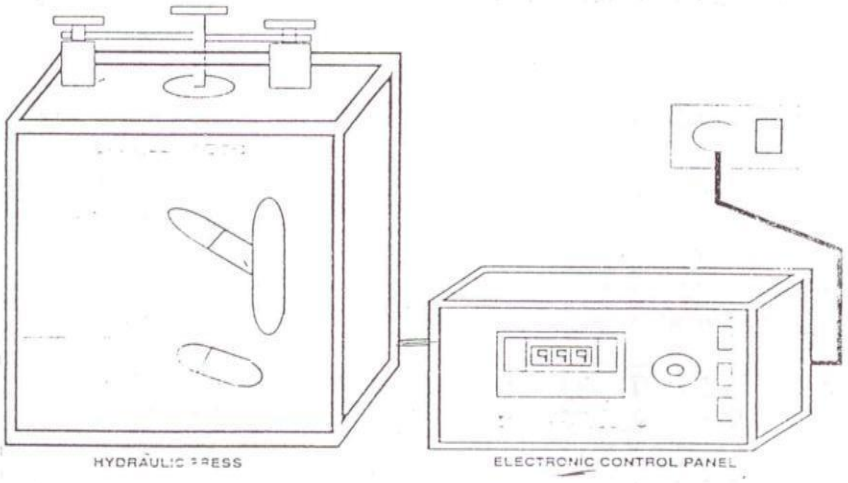
Fine polishing:- The time consumed & the success of fine polishing depends largely on the case that we exercised during the previous polishing processes. The final approximation to the flat, scratch free surface is obtained by the use of a wet rotating wheel covered with a special cloth that is charged by carefully sized abrasive particles. A wide range of abrasive is available for final polishing, while many will do a satisfying job, these appear to be presence of gamma form of aluminium-oxides (Al2O3), for ferrous & copper based materials & Cerium oxide for Aluminium, Magnesium & their alloys, other final polishing abrasives often used are diamond, chromium oxide & magnesium oxide etc. A choice of proper polishing cloth depends upon the particular material being polished & the purpose of metallographic study. Many cloths are available of varying lap or pile, from those having no pile, such as silk, to those of intermediate pile such as broad cloth, billiard cloth, canvas cloth & finally to a deep pile such as velvet synthetic clothes are also available for general purpose of which two under the trival names of gamal& micro cloth are most widely used.

Etching:– The purpose of etching is to make the many structural characteristics of the metal or alloy visible. The process should be such that the various parts of the microstructure may be clearly differentiated. This is to subject the polished surface to chemical action. In the alloys composed of two or more shapes. The competent are revealed during etching by a preferential attack of one or more of the constituents by the reagent because of difference in chemical composition of the phases. In uniform single phase alloy contact is obtained and the grain boundaries are made visible because of difference in the rate at which various grains are attacked by the reagent This difference in the rate of attack by reagent which is mainly

associated with angle of the different grain structure section to the plane of the polished surface. Because of chemical attack of the chemical reagent the grain boundary appears as valleys in the polished surface light from the microscope hitting the side of these valleys will be reflected but of the microscope making the grain boundaries appears dark lines The section of the appropriate etching reagent is determined by metal or alloys & the specific structure desired for viewing.

MOUNTED SAMPLES WITH THE HELP OF HOT MOUNTING PRESS

SPECIMEN MOUNTING PRESS



MOUNTED SAMPLES WITH THE HELP OF HOT MOUNTING PRESS

Aim: Preparation of Mounted samples with the help of mounting press/cold setting resins.

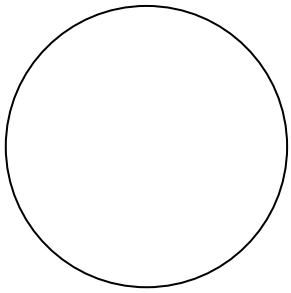
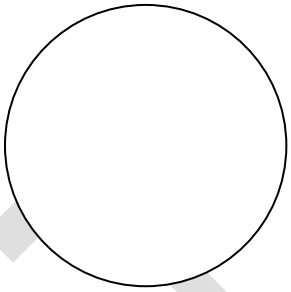
Theory: Specimens that are very small or awkwardly shaped should be mounted to favorite, intermediate & final polishing wires small rods steel, sheet metal specimens, thin sections etc. must be approximately mounted in a suitable material or rigidly damped in a mechanical mount Synthetic plastic materials applied in a special mounting press will yield amount of uniform convenient size (usually 1 inch or 1.25 inch or 1.5 inch. in diameter) for handling in subsequent polishing operation. This mounts when Properly made are very resistant to attack by etching reagent ordinarily used. The most common thermosetting resin for mounting is 'Bakelite'. Bakelite moulding powders are available in variety of colors which simplifies the identification of mounted specimen. The specimen & the correct amount of Bakelite powder is available in variety of cloves which simplifies the identification of mounted specimen. The specimen & the correct amount of Bakelite powder is placed in the cylinder of the mounting press. The temperature is gradually 150^0C & a moulding pressure of about 4000 PSI is applied simultaneously since Bakelite is set & curved when this temperature is reached, the specimen mount may be ejected from the moulding die which is still hot.

Lucite is the most common thermosetting plastic resin for mounting. It is completely transparent when properly mounted. This transparency is useful when it is polished or when it is desirable for any other reason to see the entire specimen in the mould mount unlike the thermosetting plastic, the thermosetting resin don't undergo curing at the moulding temperature, rather they set on cooling. The specimen & a proper amount of Lucite powder is placed in the mounting press & are subjected to the same temperature & pressure as for Bakelite (150^0C, 4000 PSI) After this has been reached, the heating coil is removed & cooling fins are placed around the cylinder to cool the mount to about75^0 c in about 7 minutes while the moulding pressure is maintained. Then the mount be rejected from the mould, ejecting the mount while still hot, or allowing it to cool slowly in the moulding cylinder to ordinary temperature before ejection will cause mount to remain opaque. Small specimens may be continently mounted for metallographic preparation in a laboratory made damping device. Thin sheet specimens when mounted in a damping device, are usually alternated with metal. 'Filler' sheet which have approximately the same hardness as these specimens. The

use offiller sheet will preserve surface irregularities of the specimen & will prevent to some extent the edges of the specimen from becoming rounded during polishing.

METALLOGRAPHY OF PURE METALS

METALLOGRAPHY OF ALUMINUM

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen : Aluminum	**Specimen :Aluminum**
Composition :	**Composition : 99.9% Pure**
Microstructure Details :	**Microstructure Details : Al_2O_3**
Heat Treatment (if any) : Nil	**Heat Treatment (if any) : Nil**
Etchant :	**Etchant :keller's reagent**
Etching Time :	**Etching Time : 15 seconds**

METALLOGRAPHY OF ALUMINIUM

Aim: Identification of micro – constituents present in the aluminium

Equipment &Materials: Specimen Cut off Machine, Specimen Mounting Press, Belt Grinder, Polishing Stand, Disc Polishing Machine, Drier, Metallurgical Microscope, Bakelite Powder Emery Papers (120, 220, 400, 600, 800 Grit) Etchant (Sodium hydroxide 10gm + water 90ml).

Theory: The best known characteristic of aluminium is its light weight; Aluminium has good malleability and formability, high corrosion resistance and high electrical and thermal conductivity. Pure aluminium has a tensile strength of about 13,000psi. One of the important characteristic of aluminium is its machinability and workability.

Procedure:

- The specimen being small, is mounted on bakelite using mounting press.
- The mounted specimen surface is ground until unevenness of surface is eliminated using Belt Grinder (Linsher).
- After the specimen surface is leveled it is polished on a successively fine grades of emery papers (120, 220, 400, 600, and finally on 800 grit).
- Fine Polishing is done on a disc Polisher (Rotating Polishing Wheel), the wheel is fitted with a Polishing cloth and suspension of fine alumina powder in water used as a polishing medium.
- A Scratch free surface is obtained after fine polishing for sufficient period (15 minutes)
- After fine polishing specimen is thoroughly washed with water and dried.
- The specimen is Etched for specified time using a suitable etchant (Sodium hydroxide 10gm + water 90ml).to preferentially reveals the microstructure.

Precautions:

- Grinding should be done on the emery papers only in one direction.
- While polishing the specimen uniform pressure should be exerted on the specimen.
- While going to the next grade of emery papers, the specimen has to be rotated through 90^0.
- While switching over to new emery paper, specimen should be thoroughly washed with water to remove all loose particles.
- After etching the specimen should be washed away with in a few seconds.

- Operate the Microscope Knobs gently (with out jerks)

Observation: The microstructure of the given specimen observed at magnification 450 x

METALLOGRAPHY OF PURE COPPER

Aim: Identification of micro – constituents present in the copper

Equipment & Materials: Specimen Cut off Machine, Specimen Mounting Press, Belt Grinder, Polishing Stand, Disc Polishing Machine, Drier, Metallurgical Microscope, Bakelite Powder Emery Papers (120, 220, 400, 600, 800 Grit) Etchant (Sodium hydroxide 10gm + water 90ml).

Theory: Copper is one of the non-ferrous metals, it has high electrical, and thermal conductivity, good corrosion resistance, machinability, strength and ease to fabrication. Certain properties can be improved by suitable alloying.

The main grades of raw copper commonly used are:

- High conductivity copper:99.9% Cu, 0.4% Pb, 0.005% Fe 0.02% Ag, 0.001% Br,It used for electric purpose.
- Arsenical copper 99.9% Cu, 0.04% Pb, 0.004% Fe 0.4% Ag,
- Free cutting copper, 99.9% Cu, 0.005%Pb, 0.004% Fe 0.001% Ni
- Silver – bearing copper contains 7-305 Ag and remaining as Cu

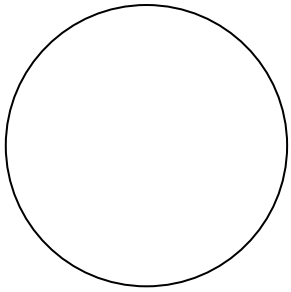
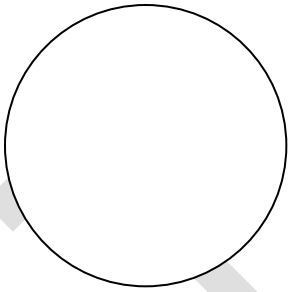
Procedure:

- The specimen being small, is mounted on bakelite using mounting press.
- The mounted specimen surface is ground until unevenness of surface is eliminated using Belt Grinder (Linsher).
- After the specimen surface is leveled it is polished on a successively fine grades of emery papers (120, 220, 400, 600, and finally on 800 grit).
- Fine Polishing is done on a disc Polisher (Rotating Polishing Wheel), the wheel is fitted with a Polishing cloth and suspension of fine alumina powder in water used as a polishing medium.
- A Scratch free surface is obtained after fine polishing for sufficient period (15 minutes)
- After fine polishing specimen is thoroughly washed with water and dried.
- The specimen is Etched for specified time using a suitable etchant (Sodium hydroxide 10gm + water 90ml).to preferentially reveals the microstructure.

Precautions:

- Grinding should be done on the emery papers only in one direction.
- While polishing the specimen uniform pressure should be exerted on the specimen.

METALLOGRAPHY OF COPPER

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen : Copper	**Specimen : Copper**
Composition :	**Composition :**
Microstructure Details :	**Microstructure Details :**
Heat Treatment (if any) : Nil	**Heat Treatment (if any) : Nil**
Etchant :	**Etchant : Nitric Acid + water**
Etching Time :	**Etching Time : 15 seconds**

- While going to the next grade of emery papers, the specimen has to be rotated through 90^0.
- While switching over to new emery paper, specimen should be thoroughly washed with water to remove all loose particles.
- After etching the specimen should be washed away with in a few seconds.
- Operate the Microscope Knobs gently (with out jerks)

Observation: The microstructure of the given specimen observed at magnification 450 x

METALLOGRAPHY OF BRASS

METALLOGRAPHY OF BRASS

Aim: Identification of micro – constituents present in the Brass.

Equipment & Materials: Specimen Cut off Machine, Specimen Mounting Press, Belt Grinder, Polishing Stand, Disc Polishing Machine, Drier, Metallurgical Microscope, Bakelite Powder Emery Papers (120, 220, 400, 600, 800 Grit), Etchant (Ferric chloride).

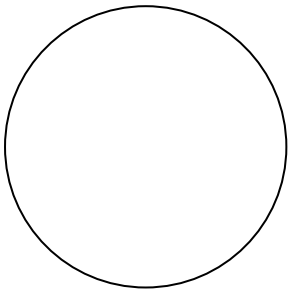
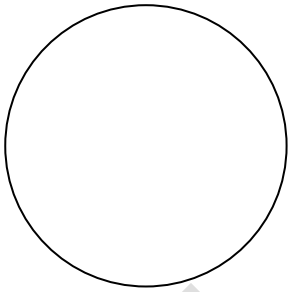
Theory: Brasses are alloys of copper; contain zinc as a principal alloying element. The equilibrium solubility of Zn in Cu is around 38% and is sharply influenced by cooling rate. Under the conditions of usual cooling rates encountered in industrial practice, the solubility limit may go down to 30%. With Zn additions exceeding the solubility limit, a second phase β is formed Beta intermediate phase exhibits order-disorder transformation between 453 and 470^0C. Below this temperature, the structure of β is ordered and above this is disordered. With more than 50 % Zn another phase γ (intermediate phase) is formed Brasses are classified either on the basis of structure i.e. α brasses and α – β Brasses or colour i.e red brasses and yellow brasses.

Brasses are soft, ductile malleable and have fairly good corrosion resistance. Commercial α – β Brasses contain zinc between 32 to 40%. They are hard and strong as compared to α- brasses and are fabricated by hot working process. these two phases alloys become single phase β (disordered) alloys at higher temperatures. Disordered β has more ductility and malleability as compared to β and therefore, α – β brasses are hot worked at a temperature of above 600 ^{0}C. Since zinc is cheaper than copper, α – β brasses are cheaper compared to α – Brasses.

PROCEDURE:

- The specimen being small, is mounted on Bakelite using mounting press.
- The mounted specimen surface is ground until unevenness of surface is eliminated using Belt Grinder (Linsher).
- After the specimen surface is leveled it is polished on a successively fine grades of emery papers (120, 220, 400, 600, and finally on 800 grit).
- Fine Polishing is done on a disc Polisher (Rotating Polishing Wheel), the wheel is fitted with a Polishing cloth and suspension of fine alumina powder in water used as a polishing medium.

METALLOGRAPHY OF BRASS

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X **Specimen : Brass** **Composition : Zn – 30%** **Microstructure Details :** **Heat Treatment (if any) : Nil** **Etchant :** **Etching Time :**	**Magnification : 450 X** **Specimen : Brass** **Composition : Zn – 30%** **Microstructure Details: consists of Brass.** **Heat Treatment (if any) : Nil** **Etchant : Ferric Chloride** **Etching Time : 15 seconds**

- A Scratch free surface is obtained after fine polishing for sufficient period (15 minutes)
- After fine polishing specimen is thoroughly washed with water and dried.
- The specimen is etched for specified time using a suitable etchant to preferentially reveal the microstructure.

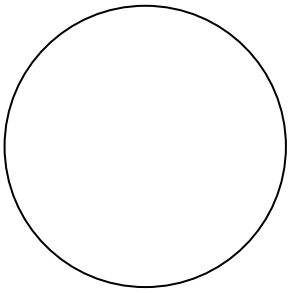
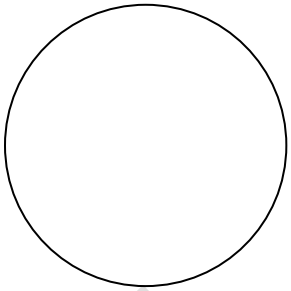
Precautions:

- Grinding should be done on the emery papers only in one direction.
- While polishing the specimen uniform pressure should be exerted on the specimen.
- While going to the next grade of emery papers, the specimen has to be rotated through 90^0.
- While switching over to new emery paper, specimen should be thoroughly washed with water to remove all loose particles.
- After etching the specimen should be washed away with in a few seconds.
- Operate the Microscope Knobs gently (without jerks).

Observation: The microstructure of the given specimen observed at magnification 450 x

METALLOGRAPHY OF CAST IRON

METALLOGRAPHY OF WHITE CAST IRON

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen : White cast Iron	**Specimen : White cast Iron**
Composition : C – 3.2 to 3.7 %	**Composition : C – 2.3 to 3.0 %**
Si – 2.0 to 3.5%	**Si – 0.9 to 1.65%**
S – 0.06 to 0.1%	**S – 0.06 to 0.1%**
P – 0.1 to 0.2%	**P – 0.1 to 0.2%**
Mn – 0.5 to 1.0%	**Mn – 0.5 to 1.0%**
Microstructure Details :	**Microstructure Details :Cementite present in pearlite matrix**
Heat Treatment (if any) : Nil	**Heat Treatment (if any) : Nil**
Etchant :	**Etchant : 2% Niltal**
Etching Time :	**Etching Time : 15 seconds**

`METALLOGRAPHY OF CAST IRON

Aim: Identification of micro – constituents present in the Cast Iron.

Equipment & Materials: Specimen Cut off Machine, Specimen Mounting Press, Belt Grinder, Polishing Stand, Disc Polishing Machine, Drier, Metallurgical Microscope, Bakelite Powder Emery Papers (120, 220, 400, 600, 800 Grit) Etchant (2% Nital).

Theory: Cast irons are basically the alloys of Iron & Carbon in which carbon content varies between 2.02 to 6.67% (Theoretically). Cast irons are brittle, and can not be forged, rolled, drawn etc., but can only be '**cast**' into a desired shape and size, by pouring the molten alloy of desired composition into mould of desired shape and allowing it to solidify. As casting is the only and exclusively suitable process to shape these alloys, these alloys are called cast irons. Carbon in cast iron may be in the form of cementite, i.e., in the combined form or graphite, the free form, or both. White Cost Irons have all the carbon in the combined cementite form. It can be recognized by the characteristics white fracture, extremely hard and brittle.

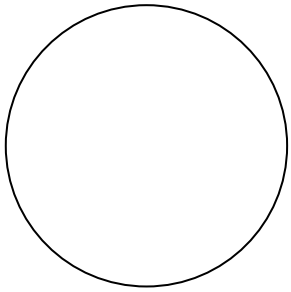
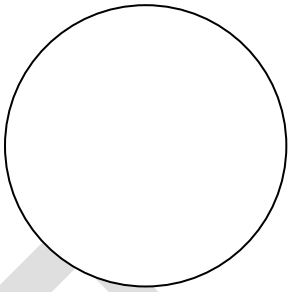
Procedure:

- The specimen being small, is mounted on bakelite using mounting press.
- The mounted specimen surface is ground until unevenness of surface is eliminated using Belt Grinder (Linsher).
- After the specimen surface is leveled it is polished on a successively fine grades of emery papers (120, 220, 400, 600, and finally on 800 grit).
- Fine Polishing is done on a disc Polisher (Rotating Polishing Wheel), the wheel is fitted with a Polishing cloth and suspension of fine alumina powder in water used as a polishing medium.
- A Scratch free surface is obtained after fine polishing for sufficient period (15 minutes)
- After fine polishing specimen is thoroughly washed with water and dried.
- The specimen is Etched for specified time using a suitable etchant (2 % Nital – 2 % HNO_3 and 98 % Ethyl or Methyl Alcohol) to preferentially reveals the microstructure.

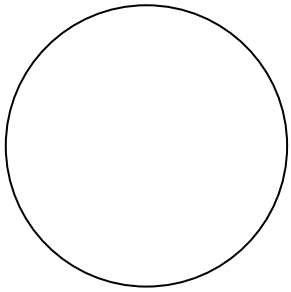
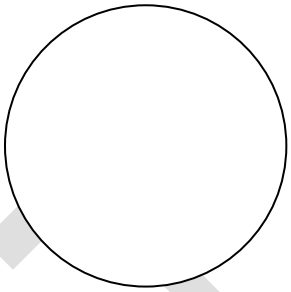
Precautions:

- Grinding should be done on the emery papers only in one direction.
- While polishing the specimen uniform pressure should be exerted on the specimen.

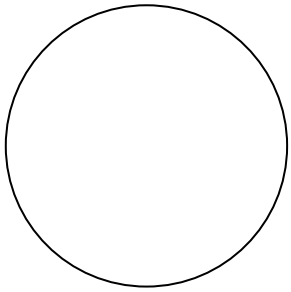
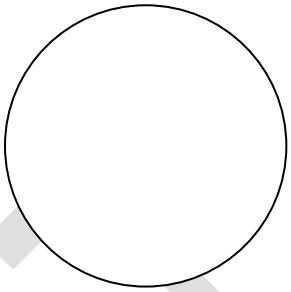
METALLOGRAPHY OF MALLEABLE CAST IRON

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen : Malleable cast iron	**Specimen : Malleable cast iron**
Composition : C – 2.0 to 2.5 %	**Composition : C – 2.0 to 2.5 %**
Si – 1.0%	**Si – 1.0%**
Mn – 0.5 to 5.5%	**Mn – 0.5 to 5.5%**
Microstructure Details :	**Microstructure Details : Cementite present in pearlite matrix**
Heat Treatment (if any) : Nil	**Heat Treatment (if any) : Nil**
Etchant :	**Etchant : 2% Niltal**
Etching Time :	**Etching Time : 15 seconds**

METALLOGRAPHY OF GRAY CAST IRON

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen :Gray cast Iron	**Specimen :Gray cast Iron**
Composition : C – 3.2 to 3.7 %	**Composition : C – 3.2 to 3.7 %**
Si – 1.4 to 1.8%	**Si – 1.4 to 1.8%**
Mn – 0.5%	**Mn – 0.5%**
Microstructure Details :	**Microstructure Details : Cementite present in pearlite matrix**
Heat Treatment (if any) : Nil	**Heat Treatment (if any) : Nil**
Etchant :	**Etchant : 2% Niltal**
Etching Time :	**Etching Time : 15 seconds**

METALLOGRAPHY OF NODULAR CAST IRON

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen : Nodular cast Iron	**Specimen : Nodular cast Iron**
Composition : C – 3.2 to 3.7 %	**Composition : C – 3.2 to 3.7 %**
Si – 2.0 to 3.5%	**Si – 2.0 to 3.5%**
Ni – 0.1%	**Ni – 0.1%**
P – 0.1 to 0.2%	**P – 0.1 to 0.2%**
Mn – 0.1 to 0.4%	**Mn – 0.1 to 0.4%**
Mg – 0.06%	**Mg – 0.06%**
Microstructure Details :	**Microstructure Details :Cementite present in pearlite matrix**
Heat Treatment (if any) : Nil	**Heat Treatment (if any) : Nil**
Etchant :	**Etchant : 2% Niltal**
Etching Time :	**Etching Time : 15 seconds**

- While going to the next grade of emery papers, the specimen has to be rotated through 90^0.
- While switching over to new emery paper, specimen should be thoroughly washed with water to remove all loose particles.
- After etching the specimen should be washed away with in a few seconds.
- Operate the Microscope Knobs gently (without jerks)

Observation: The microstructure of the given specimen observed at magnification 450 x found to be consists of Ferrite matrix with graphite flakes.

METALLOGRAPHY OF HYPO EUTECTOID STEEL

METALLOGRAPHY OF HYPO EUTECTOID STEEL (0.2%C)

Aim: Identification of micro – constituents present in the Hypo eutectoid steel.

Equipment & Materials: Specimen Cut off Machine, Specimen Mounting Press, Belt Grinder, Polishing Stand, Disc Polishing Machine, Drier, Metallurgical Microscope, Bakelite Powder Emery Papers (120, 220, 400, 600, 800 Grit), Etchant (2% Nital).

Theory: The microstructure of hypo eutectoid 0.2% C steel consists of 75% Proeutectoid Ferrite (light areas) and 25% Pearlite dark areas. The dark areas in the microstructure certainly do not look like a mixture which Pearlite is supposed to be clearly seen at higher magnification it looks like a finger print

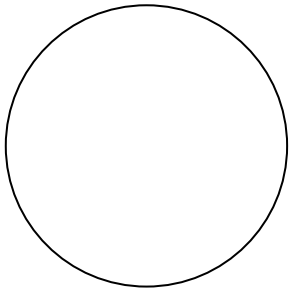
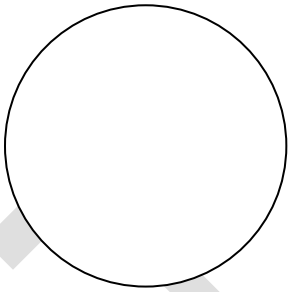
Procedure:

- The specimen being small is mounted on bake lite using mounting press.
- The mounted specimen surface is ground until unevenness of surface is eliminated using Belt Grinder (Linsher).
- After the specimen surface is leveled it is polished on a successively fine grades of emery papers (120, 220, 400, 600, and finally on 800 grit).
- Fine Polishing is done on a disc Polisher (Rotating Polishing Wheel), the wheel is fitted with a Polishing cloth and suspension of fine alumina powder in water used as a polishing medium.
- A Scratch free surface is obtained after fine polishing for sufficient period (15 minutes)
- After fine polishing specimen is thoroughly washed with water and dried.
- The specimen is Etched for specified time using a suitable etchant (2 % Nital – 2 % HNO_3 and 98 % Ethyl or Methyl Alcohol) to preferentially reveals the microstructure.

Precautions:

- Grinding should be done on the emery papers only in one direction.
- While polishing the specimen uniform pressure should be exerted on the specimen.
- While going to the next grade of emery papers, the specimen has to be rotated through 90^0.
- While switching over to new emery paper, specimen should be thoroughly washed with water to remove all loose particles.
- After etching the specimen should be washed away with in a few seconds.

METALLOGRAPHY OF HYPO EUTECCTOID STEEL

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen : Hypo eutectoid steel	**Specimen : Hypo eutectoid steel**
Composition : C – 0.2%	**Composition : C – 0.2%**
S – 0.06 %	**S – 0.06 %**
P – 0.06%	**P – 0.06%**
Mn – 0.5 to 1.0%	**Mn – 0.5 to 1.0%**
Microstructure Details :	**Microstructure Details :**
	Pro Eutectoid Ferrite in Pearlite Matrix
Heat Treatment (if any) : Nil	**Heat Treatment (if any) : Nil**
Etchant :	**Etchant : 2% Niltal**
Etching Time :	**Etching Time : 15 seconds**

- Operate the Microscope Knobs gently (with out jerks)

Observation: The microstructure of the given specimen observed at magnification 450 x found to be consists of two types of grains Pearlite (dark areas) and Pro eutectoid Ferrite (light areas)

METALLOGRAPHY OF HYPER EUCTECTOID STEEL

METALLOGRAPHY OF HYPER EUCTECTOID STEEL (1.2% C)

Aim: Identification of micro – constituents present in the hyper eutectoid steel (1.2% c)

Equipment & Materials: Specimen Cut off Machine, Specimen Mounting Press, Belt Grinder, Polishing Stand, Disc Polishing Machine, Drier, Metallurgical Microscope, Bakelite Powder Emery Papers (120, 220, 400, 600, 800 Grit) Etchant (2% Nital).

Theory: The microstructure of hyper eutectoid steel 1.2%c steel consists of 75% Pro eutectoid Cementite (light areas) and 25% Pearlite dark areas. The dark areas in the microstructure certainly do not look like a mixture which Pearlite is supposed to be clearly seen at higher magnification it looks like a finger print.

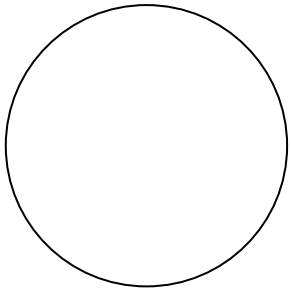
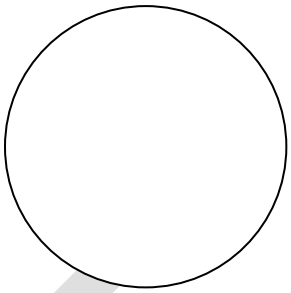
Procedure:

- The specimen being small is mounted on bakelite using mounting press.
- The mounted specimen surface is ground until unevenness of surface is eliminated using Belt Grinder (Linsher).
- After the specimen surface is leveled it is polished on a successively fine grades of emery papers (120, 220, 400, 600, and finally on 800 grit).
- Fine Polishing is done on a disc Polisher (Rotating Polishing Wheel), the wheel is fitted with a Polishing cloth and suspension of fine alumina powder in water used as a polishing medium.
- A Scratch free surface is obtained after fine polishing for sufficient period (15 minutes)
- After fine polishing specimen is thoroughly washed with water and dried.
- The specimen is etched for specified time using a suitable etchant (2 % Nital – 2 % HNO_3 and 98 % Ethyl or Methyl Alcohol) to preferentially reveals the microstructure.

Precautions:

- Grinding should be done on the emery papers only in one direction.
- While polishing the specimen uniform pressure should be exerted on the specimen.
- While going to the next grade of emery papers, the specimen has to be rotated through 90^0.
- While switching over to new emery paper, specimen should be thoroughly washed with water to remove all loose particles.
- After etching the specimen should be washed away with in a few seconds.

METALLOGRAPHY OF HYPER EUCTECTOID STEEL

BEFORE ETCHING	AFTER ETCHING
	
Magnification : 450 X	**Magnification : 450 X**
Specimen : Hyper Eutectoid Steel	**Specimen : Hyper Eutectoid Steel**
Composition : C – 1.2 %	**Composition : C – 1.2 %**
S – 0.06 to 0.1%	**S – 0.06 to 0.1%**
P – 0.1 to 0.2%	**P – 0.1 to 0.2%**
Mn – 0.5 to 1.0%	**Mn – 0.5 to 1.0%**
Microstructure Details :	**Microstructure Details :**
Heat Treatment (if any) : Nil	**Pearlite areas surrounded by a white Proeutectoid Cementite network**
Etchant :	**Heat Treatment (if any) : Nil**
Etching Time :	**Etchant : 2% Niltal**
	Etching Time : 15 seconds

- Operate the Microscope Knobs gently (with out jerks)

Observation: The microstructure of the given specimen observed at magnification 450 x found to be consists of two types of grains Pearlite (dark areas) and Proeutectoid Cementite network (light areas)

JOMINY END QUENCH TEST

JOMINY END QUENCH TEST

Aim: To conduct the hardenability test on steel by end quench test and plotting graph between distance from quenched end to Rockwell hardness.

Apparatus: Muffle Furnace, Fixture, Quick acting water valve, standard size orifice, Rockwell Hardness Testing machine.

Theory: Hardenability is defined as susceptibility to hardening by Quenching. A material that has high Hardenability is said to harden more uniformly throughout than one with heir Hardenability.

A steel quenched to 100% martensiteupto its centre may have a lower surface hardness (as its carbon content is low), but it still has higher Hardenability as compared to a steel having higher surface hardness due to 100% martensite there, but lower Hardenability.

Procedure:

- The specimens (standard size) are heated to proper austenzing temperature and soak it for required time till uniform temp is obtained throughout the cross section of the specimen.
- It is quickly placed in a fixture; water is impinged from below through standard orifice allowed from a quick acting value.
- The end Quenching continues, until the bar is cooled sufficiently (handling temperature)
- Flat edge is ground on the surface of the specimen (0.015) in deep Rockwell hardness values are determined at every 1/16 inch along the length of the specimen from the Quenched end.

PRECAUTIONS:

- Proper soaking time is given to the specimen.
- Proper care should be taken while hardening the specimen.
- The specimen must be as per IS and BS specifications.
- Keep the equipment dry and when not in use by draining the water through water outlet.

Observation: Graph is drawn between distances from quenched end to Rockwell hardness and is found to be decreasing from the end.