METALLOGRAPHY MICROSCOPE

HITECH TOOLS AND INSTRUMENTS (MUMBAI)
KRISHIT SHAH

NOTE

- The distinction between metallurgy and metallography.
- **Metallurgy** is the process of recovering metals and determining their level of reactivity, whereas,
- **Metallography** is the study of an alloy's structure using microscopic techniques.
- Microscopy, specifically the use of metallurgical microscopes, is another aspect of the metallurgical examination process.

INTRODUCTION

- Metallography is the study of metals' physical structure and components through microscopy. Metallography is defined as "the study of the atomic and chemical structure of all types of metallic alloys using microscopy."
- Metals, plastic, biological slides, cells, living microbes, and other samples are all required for testing. All of these samples differ in consistency. A metallurgical microscope is used as a high-power light source. These microscopes are commonly used in metallography, forensics, plastic processing, metal inspection, laser systems, and a variety of other material science applications.
- It is made up of an objective and an eyepiece. Its major function is to reveal information about the object. The clarity and extent to which details are displayed are determined by the degree to which these optical systems are developed. Upright microscopes use referred light from the lamp-house to test non-transparent samples. Upright metallurgical microscopes use both referred and supplied light from the top or bottom of the light sources to test transparent and non-transparent samples. Inverted metallurgical microscopes use a lamp house for referred illumination. Boom Stand Metallurgical Microscopes.

What is the need?

- Modern enterprises employ metallographic information to inform product development decisions. Metallography assists corporations in determining whether materials are stable enough to create bridges, automobiles, and motorcycles. Modern companies and manufacturers employ it as a type of quality assurance since it primarily examines how the microstructure of metals contributes to their performance. Metallography can ensure that the appropriate metal is utilised for critical applications such as automobiles, planes, and electronics.
- Metallography is also important for the development of novel materials. There are thousands of standardized alloys available now, and much more under development as demand for lighter and stronger metals rises. Microscopic examination of alloys can disclose much about their macroscopic properties, and this knowledge is utilized heavily in an alloy's design, development, and production

Process?

- 1] Sectioning and Sampling

The selection of a sample for microscopic examination may be critical. If a failure is to be explored, the sampling point should be as close to the failure as possible and compared to one obtained from the normal portion. If the material is soft, such as nonferrous metals or alloys and non-heat treated steels, the section is cut manually with a hacksaw or power saw. If the material is hard, the section can be obtained by using abrasive cut off wheels. This wheel is a narrow disc of cutting abrasive that rotates at high speed. The specimen should be maintained cold throughout the cutting process.

- 2] Rough Grinding –

When possible, choose a specimen size and form that is manageable. A soft sample can be flattened by carefully moving it up and back across the surface of a flat smooth file. The soft hard can be rough ground with a belt sander, with the specimen kept cold by often immersing in water during the grinding process. In all grinding and polishing operations, the specimen should be moved perpendicular to the existing scratches. This will make it easier to recognise the stage when the deeper scratches are replaced by shallower ones, which are characteristic of finer abrasives. The hard grinding is maintained until the surface is level, clear of wire brushes, and any scratches from the hacksaw or cutoff wheel are no longer visible.

Process?

- 3] Polishing:

It is the process of applying a chemical reaction or rubbing a surface to make it glossy and smooth, leaving a surface with a noticeable reflection. Using abrasives (often alumina powder) suspended in a water solution on an electrically powered wheel coated in cloth is the process of polishing. Removing the damage caused by cutting and grinding is the aim of polishing. AFTER THIS POINT, DO NOT TOUCH THE SAMPLE SURFACE.

4]Etching:

Etching is a method that uses selective chemical attack to reveal the metal's microstructure.A perfectly polished, unetched specimen can only have a few structural characteristics, like inclusions and fissures, or other physical flaws, visible under a microscope. A surface layer of disturbed metal from the final polishing step is always present and needs to be removed, even in a well prepared sample. Etchants are often diluted acids or alkalis in a solvent such as alcohol, water, or another. Because of the variations in the rates of attack and orientation of the different phases present, etching happens when an acid or base is applied to the surface of the specimen. Typically, all that is needed to complete the etching process is to apply the proper solution to the specimen surface for many seconds to several minutes.

Techniques to Evaluate

Metal microstructure can be ascertained using a variety of metallographic methods. The most widely utilized technique is brightfield (BF) light microscopy. Additional metallographic methods encompass color etching, differential interference contrast (DIC), and darkfield illumination.Brightfield (BF) illumination directs light onto the specimen from the top of the microscope. Following the sample's reflection of the light, a picture is transmitted to the eyepiece or camera for inspection. This method is frequently employed since it is thought to be the easiest.

Even though it is not as well-known, darkfield (DF) microscopy is a potent method for studying the microstructure of alloys. By indirect lighting the specimen, more subtle flaws can be seen because of the reduced light intensity made possible by this technique. Differential interference contrast (DIC) measures surface height differences by using an analyzer, polarizer, and prism.In most metallographic applications, microstructure color provides no useful information, but in rare cases, it is required. Here's where color etching comes in handy. Tint etchants are used chemically or electrochemically to coat the specimen's surface in a thin layer. This film reflects light from the microscope, revealing more details in the microstructure of some commercial alloys, such as Fe, Cu, and Al.

Etchings

Etching Reagent	Composition	Use
Nitric Acid	White nitric acid '1 to 5 ml ethyl or methyl alcohol'100 ml(95%	Carbon steels and cast iron
Picric acid	Picric acid '49 ethyl or methyl alcohol'	Carbon steels
Ferric chloride and hydrochloric	Ferric chloride and hydrochloric acid 50 ml water 100 ml	Structure of austenitic nickels stainless steel
Ammonium hydroxide and hydrogen	Ammonium hydroxide 90 parts water 5 parts hydrogen peroxide 2 to 5	Copper and its alloys
Palmerton reagent	Chromic oxide 200 gm sodium sulphate 15 gm water	Zinc and its alloys
Ammonium molybdenum	Molybdic acid 100 gm ammonium hydro 140ml water 240 ml, filters add to nitric acid S.P.gr. 60 ml	Lead and its alloys
Hydrofluoric acid	Hydrofluoric acid 0.5 ml	Aluminum and its

Precautions

- When doing this step of the procedure, bear in mind a few fundamental guidelines.
- Tidiness! Particularly the polishing area, keep the room and the work spaces tidy. Because abrasive is used at progressively finer grades during the polishing process, optimal outcomes necessitate that both your. Before moving on to the next phase of the procedure, make sure the sam ple and your hands are clean of any abrasives at each stop. When you are finished, cover the wheels and turn off the power. Wipe down the countertop and clean up any water spills.
- Empty the remaining etchants into a sink filled to the brim with water. As soon as possible after use, swabs should be rinsed and disposed of in the trash. Fill your receptacles with water, then rinse in methanol, and place them on the shelf above the sink.
- When working with chemicals, wear gloves and safety eyewear. Should there be an acid leak or if fresh etchants are required, get in touch with the instructor or the T.A. When utilizing hydrofluoric acids, use extra caution.4) Refrain from eating or drinking anything while doing lab work. When you exit the lab, make sure to properly wash your hands with soap.

Microstructure Correlate With Physical Properties

- Decreased grain size is associated with higher yield strength and hardness.
- Ductility is lower in metals with a higher inclusion rating.
- Inclusion content and distribution directly influence a metal's cracking rates and fracture resistance.
- Inconsistencies or "discontinuities" in a metal's microstructure are associated with failure sites, or the spot where the metal breaks.

CATEGORIES

Upright Microscopes with reflected light only

In which the light comes from top lamp-house and is used for non-transparent samples

Upright Metallurgical Microscopes with reflected and transmitted lights

in which light can come from top and bottom light sources and can be used to examine the transparent and non-transparent samples

Inverted metallurgical Microscopes

which includes a lamp house for reflected illumination.

Boom Stand Metallurgical Microscopes

Recommendation to buy this accessories along with the Microscope:

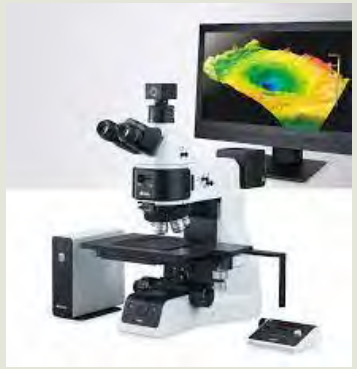
- Medium, large or extra-large XY stage?

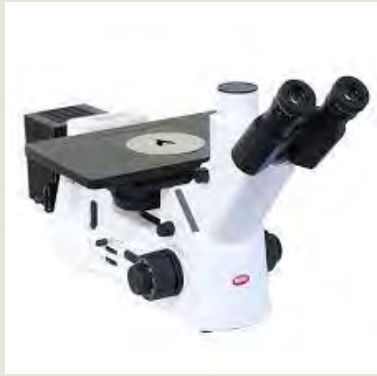
Most of the metallurgical samples are often large, like 6" or even more. Thus make sure the microscope stage can support that. Most of the metallurgical microscopes come with 4"x4" or 100x100mm XY stage. If that is not enough, the next version is normally 6×6 in. If you need even larger than a 6" stage, then choose Bioimager extra large stages which are from 8", up to 14". These stages come with anti-vibration table.

- Imaging Capabilities

a) BF or DF? By default all metallurgical microscopes come with brightfield (BF) imaging. If you need to have darkfield (DF) imaging, you do need to decide during the purchase time as upgrading such a feature will not only be costly but also will result in loosing the money you spent on BF module and also the obj lenses. Switching between BF and DF is always super easy, just move a lever.

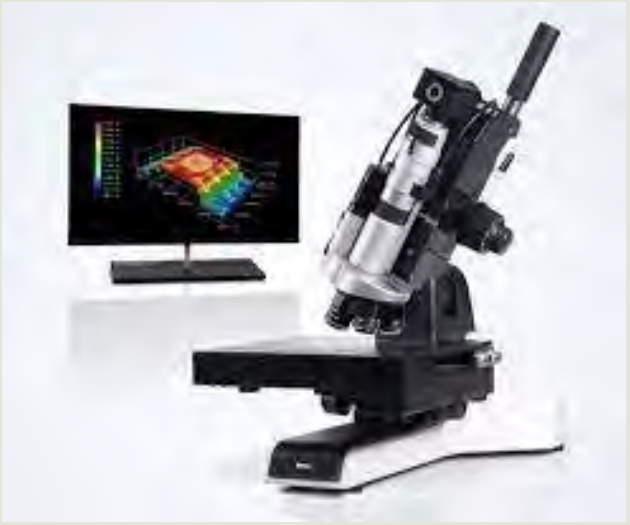
b) DIC Nomarsky or not? DIC Nomarsky imaging needs a polarizer and analyzer. Make sure your microscope does / will come with polarizer, analyzer, slot for DIC insert and also which objective lenses are supported for DIC imaging. If your microscope allows having a DIC imaging but your budget does not permit, make sure you can upgrade that by simply purchasing the extra parts without discarding your current obj lenses or setup.





3D PROFILER

- One of the most interesting and useful feature of the metallurgical microscopes is having a 3D profiler which allows measurement of the height and/or thickness of a sample.
- This is a great tool for inspection of the materials or scaffold are made in three-dimensional, such as 3D tissue or dental cements.



Transmitted Light

Specimen Type	Imaging Technique
Transparent Specimens -Bacteria, spermatozoa, cells in glass containers, protozoa, mites, fibers, etc.	Phase Contrast Oblique Illumination Darkfield Illumination
Light Scattering Objects -Diatoms, fibers, hair, fresh water microorganisms, radiolarians, etc	Phase Contrast
Light Reflecting Specimens -Colloidal suspensions, powders and minerals, liquids	Phase Contrast Dispersion Staining
Amplitude Specimens -Stained Tissue, naturally colored specimens, hair & fibers, insects and marine algae	Brightfield Illumination
Fluorescent Specimens -Cells in tissue culture, fluorochrome-stained sections, smears and spreads	Fluorescence Illumination
Birefringent Specimens -Mineral thin sections, liquid crystals, melted and re-crystallized chemicals, hairs & fibers, bones & feathers	Polarized Illumination

Reflected Light

Specimen Type	Imaging Technique
Specular (Reflecting) Surfaces -Thin film, mirrors, polished metallurgical samples, integrated circuits	Brightfield Illumination Darkfield Illumination
Diffuse (Non-Reflecting) Surfaces -Thick and thin films, rocks & minerals, hair, fiber, bone and insects	Brightfield Illumination Darkfield Illumination Polarized Illumination
Amplitude Surface Features -Dyed fibers, diffuse metallic specimens, composite materials, polymers	Brightfield Illumination Darkfield Illumination
Birefringent Specimens -Mineral thin sections, hair & fibers, bones & feathers, single crystals, oriented films	Polarized Illumination
Fluorescent Specimens -Mounted cells, fluorochrome-stained sections, smears and spreads	Fluorescence Illumination

SPECIFICATIONS OF SOFTWARE

- **Grain size analysis-**

Follow ASTM E112 standard.

Automatically creates grain boundary structure.

Supports planimetric method, Hayn Linear intercept method, Hillard/abrams circle intercept method.

Manual grain analysis of particular grain(s) of a specific region.

User can manually draw grains if structure is not properly visible. They can remove grain boundary formed. Can create custom grain analysis program using different image analysis functions that suites different types of grain.

ALA Grain size (ASTM E930) analysis.

- **Phase/Segmentation**

As per standard ASTM E562.

User can define different configurations for different measuring conditions and analysis.

Can import data from Nodule analysis or Flakes Analysis (Graphite Data). Detect Nodules in the image.

Can split phases which has same colour range.

Supports manual point count method for phase analysis.

Report with graphite (nodule/flake) data and phase data.

- **Inclusion analysis**

Using ASTMstandard E45.

Group results as per type A, B, C, D and further classification as thin & Thick.

SPECIFICATIONS OF SOFTWARE

- **Porosity analysis-**

User can define configuration with different filter condition.

User can manually select or unselect a feature. In between user can switch to live video to further analyze a feature by focus adjustment and can select or unselect a feature in processed image.

Can group the selected feature into different buckets based on length or area.

- **Nodularity analysis-**

Using ASTM standard E2567.

User can define configurations with different filter conditions, gives nodularity by count, by area & size.

Group results using nodule size 1 to 8.

- **Decarburization Analysis as per ASTME1077 Dendrite Arm Spacing (for Aluminium) Particle analyzer-**

Analyze can detect particles/features in an image.

User can define configurations with different filter conditions, analyze features/particles for length, area, circularity.

Can group features into different buckets based on Length, area, cicularity.

- **Coating thickness measurement-**

By analyzing the cross section image gives minimum-maximum thickness, average & standard deviation.

Automatically identifies the coating boundary.

SPECIFICATIONS OF SOFTWARE

- **Flake analysis-**

As per ASTM A247method, detects groups flakes into type A, B, C, D & E.

Detects group flakes into size 1 to 8. User can manually change flake type.

- **2D Measurement**

All 2D measurements like length, area, radius diameter, angle, distance between two points.

Support boundary tools like line, point, circle, arc, curve, angle.

- **Reports in PDF & Excel**

THANK YOU

Krishit shah

HITECH TOOLS & INSTRUMENTS
hitechti2013@gmail.com
+919004658741