



National Award for  
Outstanding Entrepreneurship - 2010



National Award for  
Quality Products in Instrumentation - 2002

## WORLD OF METALLURGICAL MICROSCOPES FOR MICROSTRUCTURE ANALYSIS

### What is a Metallurgical Microscope ?

A Metallurgical Microscope is like any other Optical Microscope with the exception of lighting orientation. A Metallurgical Microscope uses a different lighting method, that can illuminate solid specimens to identify, inspect & measure them. Some Industries use Inverted Metallurgical Microscope which observe the specimen from below the stage. Electronic part manufacturers, Forensic laboratories & Metal Foundries, all use this type of instrument.

A conventional microscope illuminates a transparent specimen from below the stage, making it visible through the eyepiece. Since light cannot penetrate opaque or solid objects, this is not a suitable method for observing these samples under magnification. Metallurgical Microscope illuminate objects from above, either with an external light source or with the light travels through the magnification objectives using beam splitters. This lighting technique illuminates the entire object without creating distraction or unnecessary reflections.

The illumination technology may include color filters or filters designed to change polarization and light intensity. These options allow viewing objects in bright or dark field applications. The filters may be contained in a removable cartridge within the microscope body.

Inverted Metallurgical Microscope has the objective under the stage, which allows viewing of specimens that vary in size. As individuals typically use a Metallurgical Microscope for observing surface structure, large items can be placed on the stage without anything coming into contact with the objectives. Researchers also place flasks or bottles on the stage, observing micro-organisms within a liquid environment.

Electronics parts manufacturers often use a Metallurgical Microscope as a quality control instrument, inspecting parts for microscopic defects. Forensic labs use the instrument for identifying firing patterns on bullets and casings or for analysing the surface area of bones and other material. Metal foundries use Metallurgical Microscopes for grain analysis and to determine the structure of manufactured metals. Scientists use the microscopes for analyzing and identifying metal components.

### Preparation of Metallography Samples

It is one of the critical parts of metallographic examination of a sample. metallographic specimen is typically mounted using a flat compression thermo setting resin. Bakelite powder or more recently modern epoxy is becoming more popular because reduce shrinkage during curing results in a better mount with superior retention. A typical mounting cycle will compress the specimen and mounting media and heat to a temperature of approximate 177°C. When specimens are very sensitive to temperature, "cold mounts" may be made with a two part a epoxy resin. Mounting a specimen provides a safe, standardised and ergonomic way by which to hold a sample during the grinding and polishing operations.



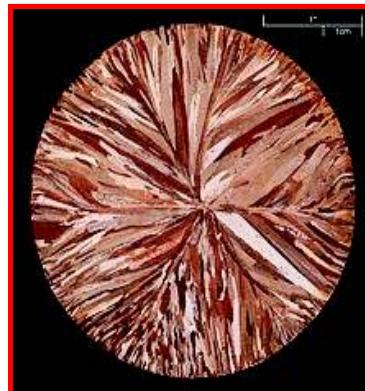
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Presenting  
a world of  
**Metallurgical  
Microscopes**  
by  
”  
**Vaiseshika**



## MICROSTRUCTURE ANALYSIS TECHNIQUES

### Grinding And Polishing

After mounting, the specimen is wet ground to reveal the surface of the metal. The specimen is successively ground with finer and finer abrasive media. Silicon carbide abrasive paper was the first method of grinding and is still used today. Many metallographers, however, prefer to use a diamond grit suspension which is dosed onto a reusable fabric pad throughout the polishing process. Diamond grit in suspension might start at 9 microns and finish at one micron. Generally, polishing with diamond suspension gives finer results than using silicon carbide papers (SiC papers), especially with revealing porosity, which silicon carbide paper sometimes 'smear' over. After grinding the specimen, polishing is performed. Typically, a specimen is polished with a slurry of alumina, silica, or diamond on a napless cloth to produce a scratch-free mirror finish, free from smear, drag, or pull-outs and with minimal deformation remaining from the preparation process.



A Macro Etched Copper Disc

### Role of Flatness in Metallographic Samples

It is very important that mounting of the sample and its grinding and polishing must be done in such a way that final sample should be perfectly flat. In metallography generally work is done at higher magnification of 500X to 1000X. If the sample is uneven even in microns, at that magnification level, sample observation will not be uniformly visible over entire field of view (you will get some portion focussed and some portion defocussed).



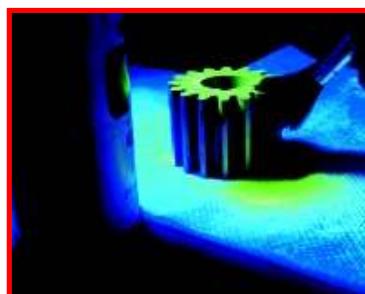
Flat Sample in Bakelite Material

### Analysis Techniques

Many different microscopy techniques are used in metallographic analysis.

Prepared specimen should be examined with the unaided eye, after etching, to detect any visible areas that have responded to the etchant differently from the norm as a guide to where microscopical examination should be employed. Light optical microscopy (LOM) examination should always be performed prior to any electron metallographic (EM) technique, as these are more time-consuming to perform and the instruments are much more expensive.

Further, certain features can be best observed with the LOM, e.g., the natural color of a constituent can be seen with the LOM but not with EM systems. Also, image contrast of microstructures at relatively low magnifications, e.g., <500X, is far better with the LOM than with the scanning electron microscope (SEM), while transmit.

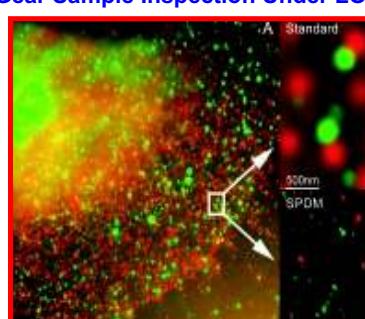


Gear Sample Inspection Under LOM

### Design, Resolution, and Image Contrast

Light microscopes are designed for placement of the specimen's polished surface on the specimen stage either upright or inverted. Each type has advantages and disadvantages. Most LOM work is done at magnifications between 50 and 1000X. However, with a good microscope, it is possible to perform examination at higher magnifications, e.g., 2000X, and even higher, as long as diffraction fringes are not present to distort the image.

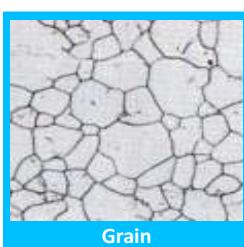
Besides considering the resolution of the optics, one must also maximize visibility by maximizing image contrast. A microscope with excellent resolution may not be able to image a structure, i.e. there is no visibility, if image contrast is poor. Image contrast depends upon the quality of the optics, coating on the lenses, and reduction of flare and glare; but, it also requires proper specimen preparation and good etching techniques. So, obtaining good images requires maximum resolution and image contrast.



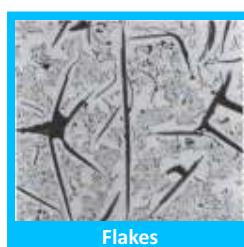
Partial Contrast of Metal Powder



Phase



Grain



Flakes



Coating

Images taken on Metallurgical Microscopes Through Image Capturing Device

## UPRIGHT METALLURGICAL MICROSCOPE : UMS 7001A

### DESCRIPTION

Vaiseshika® introduces a range of sophisticated Metallurgical Microscopes. These microscopes have been designed to conduct microstructure examination of metallographic specimen. Optical detection of surface irregularities/inclusions and faults in metals can also be observed with the microscope. The instrument is having superb capability to reveal significant specimen details with outstanding relief in black and white or brilliant colours. The metallurgical experts will find this microscope a versatile equipment for non-destructive testing of materials in ceramics, textiles, petrochemicals, avionics, defence, research and development establishments. Above all the additional camera attachment for microphotography makes microscope an excellent quality control equipment for the engineering industry.

### FEATURES

- Incident light microscopy for metallography
- Optional **Polarizer** and **Analyzer** attachment
- Magnification range 25x to 2000x
- Spring loaded objectives at higher magnification to avoid damage to optics or specimen
- Coaxial coarse and fine focusing
- Perfect transmission system having localized illumination and flatness of field
- PC interface facility with camera and image analysis measurement software for micro-photography
- 6V/20 watts halogen lamp for better illumination & adjustable brightness



UMS 7001A

### SPECIFICATION

<b>Magnification</b>	100X to 400X with standard eyepieces & objectives 25X to 2000X with optional eyepieces & objectives
<b>Standard Eyepieces</b>	WF 10X / Ø18mm
<b>Optional Eyepieces</b>	5X, 15X & 20X Micrometer 10X with least count = 0.1mm Filar Micrometer 10X Grain size measurement WF 10X (08 grains)
<b>Standard Objectives</b>	Achromatic 10X/0.25, 40X/45X/0.6
<b>Optional Objectives</b>	Achromatic 5X, 20X, 60X & 100X (Oil or Dry)
<b>Viewing Head (45° Angle)</b>	Trinocular, interpupillary distance : 55mm to 75mm
<b>Light Distribution</b>	100 : 0% between camera port & binocular eyepieces
<b>Color Filters</b>	Yellow, Blue & Green
<b>Focusing System</b>	Coaxial coarse & fine focus system
<b>Nosepiece</b>	Quadruple (Frontward ball bearing inner locating)
<b>Polarizer &amp; Analyzer</b>	Set of polarizer & Analyzer attachment ( <b>Optional</b> )
<b>Mechanical Stage</b>	Two layer & three-axis moveable with coaxial X-Y movement. Size : 128 X 86mm, Travel : 30 X 30mm
<b>Illuminator</b>	6V / 20W, 220V AC/50Hz, Halogen lamp, adjustable brightness

## UPRIGHT METALLURGICAL MICROSCOPE : UMS 7001B

### FEATURES

- Suitable to observe surface of opaque object or transparent object
- Equipped with **Long Working Distance Plan**, Achromatic Objectives and wide field eyepieces, provide excellent optical quality and operation performance.
- Selection of the illumination mode such as reflected, transmitted and reflected light, working independently or synchronously, required for different sample checking.
- Ideal instruments in research work for metallography, mineralogy, precision engineering, electronics etc.
- Color CMOS or CCD Camera with measurement Software gives wonderful capability for metallographic analysis and calculations
- Kohlar illumination system with clear & high contrast pictures

HP BF



### SPECIFICATION

#### UMS 7001B

<b>Magnification</b>	50X to 600X with standard Eyepiece & Objectives 12.5X to 2000X with optional Eyepieces & Objectives
<b>Standard Eyepieces</b>	High Point, WF 10X/Ø18mm
<b>Optional Eyepieces</b>	5X, 12.5X, 16X, & 20X. Micrometer WF 10X with least count =0.1mm. Filar Micrometer 10X . Grain size measurement WF 10X (08 grains). Objective Micrometer Disc with least count =0.01mm
<b>Standard Objectives</b>	Plan Achromatic 5X/0.12, 10X/0.25, 40X/0.60 & 60X/0.80
<b>Optional Objectives</b>	2.5X, 20X, 50X/0.70, 100X/0.9 (Oil/Dry)
<b>Viewing Head(Inclined at 30°)</b>	Sidentop Trinocular (with integrated Analyzer) Interpupillary distance: 55mm to 75mm,adjustable angle for eyepieces
<b>Light Distribution</b>	100:0%, between camera port and binocular eyepieces
<b>Color Filters</b>	Yellow, Blue, Green & Ground (for Epi-Illumination) B filter & frosted glass (for Transmitted Illumination)
<b>Focusing System</b>	Coaxial coarse & fine focus with tension adjustable & up stop fine focus : 2 um
<b>Nose Piece</b>	Quadruple(Backward ball bearing inner locating)
<b>Mechanical Stage</b>	Double/three layer & three axis moveable, Size:185mmX140mm, Travel : 75mmX50mm
<b>Epi-Illumination</b>	6V/20W, 220V AC/50Hz, Halogen lamp, adjustable brightness. Integrated field, aperture diaphragm & filter switching device. Puller <b>Polarizer</b>
<b>Transmitted illumination</b>	6V/20W, 220V AC/50Hz, Halogen lamp, adjustable brightness, outside field diaphragm, Abbe condenser NA 1.25 rack & pinion adjustable

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