

## Portable Metallography Microscope

### SM500



**BMS Bulut Makina Sanayi Ve Ticaret Ltd. Şti.**

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SM500 metallurgical microscope is fit for metallurgical examination and failure analysis of large work-piece on site. Without cutting and sampling, directly grind, form phase, observe and photograph on work-pieces. For work-pieces, especially finished pieces, no damage. It can improve examination efficiency of metal, perfect quality control of products in factory. At the same time, it is also used in metallurgical observation in lab.

## 1 Configuration

Microscope

Microscope body

Eyepiece: 10×, 12.5×; matching 20 ×

Objective lens: 10×, 40×; matching 25×

Lamp socket: lamp holder, 6V 15W halogen lamp

Magnetic base: mechanical magnetic on off; matching with small caliber base; lab base

Dimmer power box

Input 220V, 50/60HZ;

Output 0-15V; matching with chargeable power

Mini-type speed regulation grinder (Optional)

125W, 220V 10.000~33.000 RPM infinite speed variation grinding and polishing assembly

Carrying case

Dimensions: 475×270×160

Film laminated paper

Dilute solution --- acetone

Metallographic camera (optional)

Digital camera

Digital camera interface

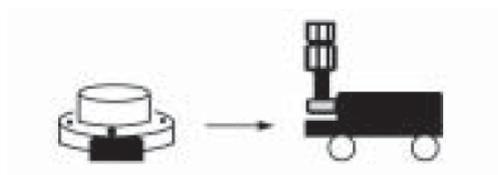
## 2 Microscope Installation

Installation of microscope lens

Eyepiece is directly inserted into eyepiece sleeve on the top of microscope. Objective lens is tightened clockwise on objective lens socket at the bottom of microscope.

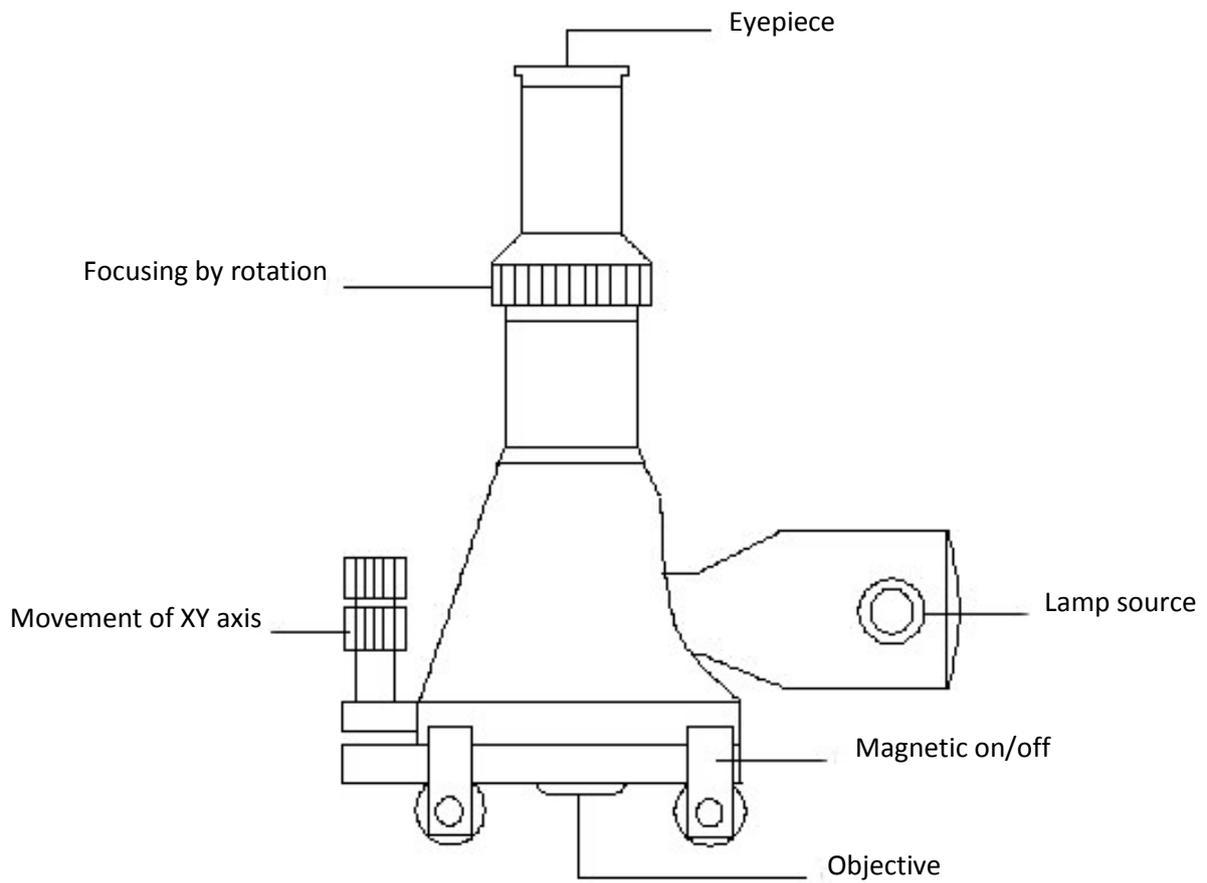
### 2.1 Installation of curved surface base

During inspecting surface of small caliber work-pieces or other complex work-pieces, loosen four replacement set screws on the uppermost layer of original magnetic base. Take out of microscope body and screw on special magnetic base.



### 2.2 Angle wheel sander blade

Install in turn 200# wheel, 400# wheel, 600# wheel and felted wool wheel strictly according to operation instruction with angle grinder. Install also wheel head from rough to fine according to operation instruction.

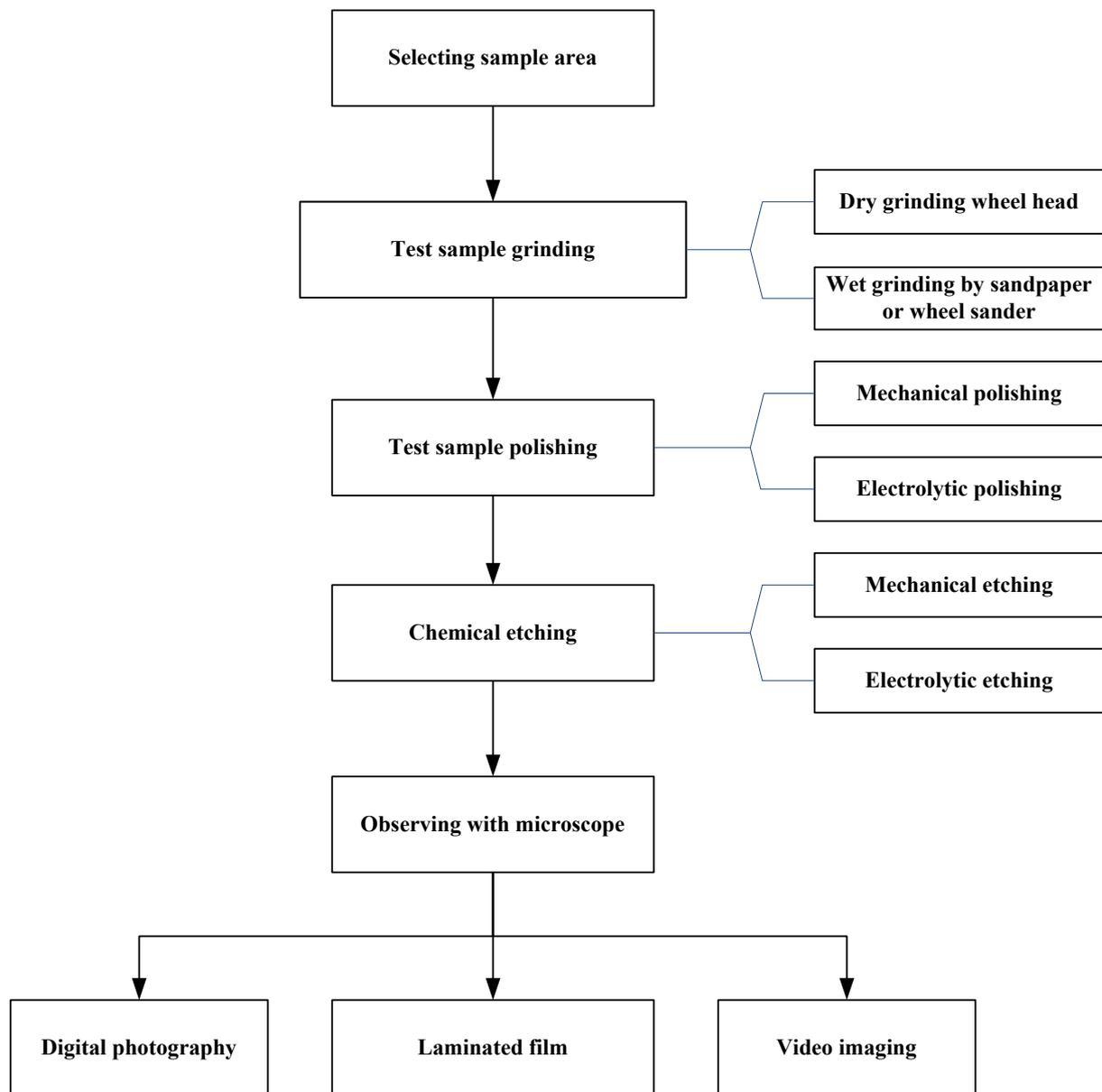


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### 3 Schematic Diagram for Operation



### 4 Operation

Safety goggles should be worn before using grinder. At the same time, check if wheel head is tightened by wrench in order to prevent from flying wheel head and causing accident.

Follow the chemical operation procedure strictly due to that the chemical polishing liquid is strong acid solution in order to avoid liquid splashing on face, hand and clothes, etc.

#### 4.1 Work-piece pretreatment

Clear up rust, oxidizing layer and severely deformed layer on the surface of work-pieces by angle grinder

#### 4.2 Grinding

Dry grinding: Install wheel head from rough to fine on the mini-type speed regulation grinder in turn. The colors of wheel heads are marked: 80# (Blue), 120# (Clay), 240# (Green), 320# (Yellow), 500# (Coffee) and 700# (Pink)

Wet grinding: Stick sandpaper with plastic film 100#, 240#, 400#, 600#, 800#, 1000# and 1200# in turn to rubber flat head or flat head of wheel sander.

#### 4.3 Operation precautions

Grinding pressure should be uniform and moderate. Too low pressure will cause low grinding efficiency. Too large pressure will increase rolling between abrasive particles and test sample surface to produce too deep indentation. When time is too long, heat will cause new deformed layer.

During changing wheel head and grain size on the sand paper, surface should be cleaned up.

During changing wheel head each time, turn 90 degree to grind vertically to observe the condition of eliminating rough grinding crack at the next higher level.

The serial number of sandpaper refers to new standard GB/T 9258-2000.

#### 4.4 Polishing

Carry out mechanical polishing by diamond dust added on the plush flannelette wheel or short pile piece with plastic film. Usually use paste form polishing paste and spray polishing agent. After polishing, clean surface of test sample.

Or polish by using electrolytic polishing device. (See electrolytic polishing)

#### 4.5 Chemical etching

Wipe grinding surface by using chemical agent to make it show its organization. Different materials are required selecting different etching solution.

Kind of material	Composition of etching solution	Operation conditions	Applicable note
Carbon steel, alloy steel and Cast-iron	Nitric acid (1.4) 1-10ml Alcohol 100ml	Usually use 3% Ethanol nitrate solution 5%-10% applicable for high alloy steel Etch for several seconds ~ one minute	Pearlite is blank. Occluded foreign substance is shown in crystal boundary of ferrite in low carbon steel.
	Picric acid 4g Alcohol 100ml	Add 0.5%~1% Zephirol, dimethyl and alkyl ammonium to improve corrosion rate. Etch for several seconds ~ one minute	Used in organization containing ferrite and carbide. Crystal boundary of ferrite is not shown. Pearlite and bainite can be distinguished.
	Hydrochloric acid 5ml Picric acid 1g Alcohol 100ml	The size of crystal grain is shown. Etch for several seconds ~ one minute	Show tempered crystal boundary of austenite and tempered martensitic structure.
Stainless steel	HNO <sub>3</sub> one piece HCL one piece Water one piece	Require wiping continuously	General agent of stainless steel Show grain structure
	Picric acid 1g HCL 5ml Alcohol 100ml	Not more than 1min	Show contour of carbide, ferrite with $\sigma$ phase or $\delta$ phase etc. Martensite is etched.
Casting	Iron chloride 4g Sulfuric acid 40ml Sodium sulfite 2g Distilled water 100ml	Not more than 10 seconds	Ferro steel and magnesium iron arborescent structure, eutectic distribution and black lead distribution

#### 4.6 Microscope observation

Insert eyepiece into eyepiece sleeve and screw off protective cap of objective lens and screw on objective lens.

Enlargement ratio= eyepiece $\times$  objective lens.

Open lamp source and align optical pattern of objective lens with sampling position. Turn on off magnetic wrench and suck the microscope.

Rotate and focus up till image is clear.

Adjust positions of lamp holder and lamp socket till illumination in full field is uniform.

#### 5 Image retention

After observing test sample, under the condition that photography is not easy, replicate metallurgical structure by laminated film then bring to lab for photography.

Drip one-drop acetone solution on the surface of dried test sample. Stick laminated film finely to the position of test sample. At this time, excessive acetone solution and air bubble are squeezed out.

Notice: air bubble cannot be removed by hand and should be removed during sticking film from one side.

Molecular adsorption between thin film dissolved by acetone and metal surface and air pressure on the thin film make thin film and surface of test sample contact and apply more closely in order that internal structure of test sample is printed on the thin film to become replicated film with negative structure.

Within very short time, thin film is drying and peeling off naturally. Usually, its shape is bending. Place thin film on the glass by keeping film surface upwards and fix around the thin film by scotch tape (cover it by extremely thin sheet glass).

## 6 Electrolytic Polishing

For some metal materials that have lower solidness and are easy to form deformed layer, For example, high manganese carbon steel, martensitic stainless steel and softer nonferrous metal, or under the condition of inspecting in bulk the same material, effect of electrolytic polishing is better.

After finishing 180#-300# rough grinding, carry out electrolytic polishing.

Screw on electrolytic pen cap and squeeze adsorption paper or absorbent cotton plug into styli hole to make the surface flat. Then drip electrolytic solution. Anode holder is absorbed on the conductive surfaces of work-pieces.

Select sampling position to stick to absorption paper (limiting current) then adjust voltage values to begin polishing.

According to thin film theory, set voltage and current:

### 6.1 Formulation of electrolytic polishing solution:

Proportioning of electrolytic solution	Current A	Voltage V	Time S	Applicable material
Perchloric acid 50ml Alcohol 750ml Water 140ml	0.3---1.3	8---20	20---60	Steel and stainless steel
Perchloric acid 62ml Alcohol 700ml Fiber—Butyl solubilization 100ml Water 138ml	1.2	10--30	20	High and low carton steel and high speed steel
Strong H3PO4	0.6	40	20---60	Stainless steel
HNO3 50ml Water 50ml		2---6		Stainless steel etching
Ortho phosphoric acid 500ml Bengal isinglass 5g Sodium hydroxide 5g	20 .2.5---5		60---90.4	Polishing and etching of aluminum alloy
Sulfuric acid 8ml Phosphoric acid 50ml	20---30		1.5---2min	Film is laminated on aluminum anode and aluminum alloy anode.
Ortho phosphoric acid 300ml Water 400ml	30---40		10---20	Copper