introduction

The MINIMET® Polisher/Grinder has been an outstanding success since its introduction. It has filled a long standing need for a compact economical polisher for smaller laboratories.

Experiments in the BUEHLER R&D Lab and successful applications reported by our customers demonstrate exceptional MINIMET® versatility, making it a necessary addition for a small laboratory and an ideal choice for specialized techniques in any laboratory.

In the subsequent pages, an explanation of the MINIMET® operating principles and prerequisites will be found. Furthermore, basic preparation procedures for common materials and an introduction to special techniques and accessories used to solve different sample preparation problems are discussed as outlined below:

preparation procedures

SEQUENCE A. Common Alloys of Moderate Hardness
SEQUENCE B. Harder Alloys
SEQUENCE C. Complex Composites and Other Special Cases

special preparation techniques

PART I—Attack Polishing
PART II—Electro-mechanical Polishing
PART III—Thin Section Polishing
PART IV—Precision Thinning for Ion Milling
PART V—Wafer Polishing

Prior to the introduction of the MINIMET® Polisher/Grinder, rotating polishing wheels were the nearly exclusive means of preparing polished samples for metallography and the material sciences. The versatile, compact MINIMET,® with its ever increasing applications, has had a significant impact upon modern metallography.

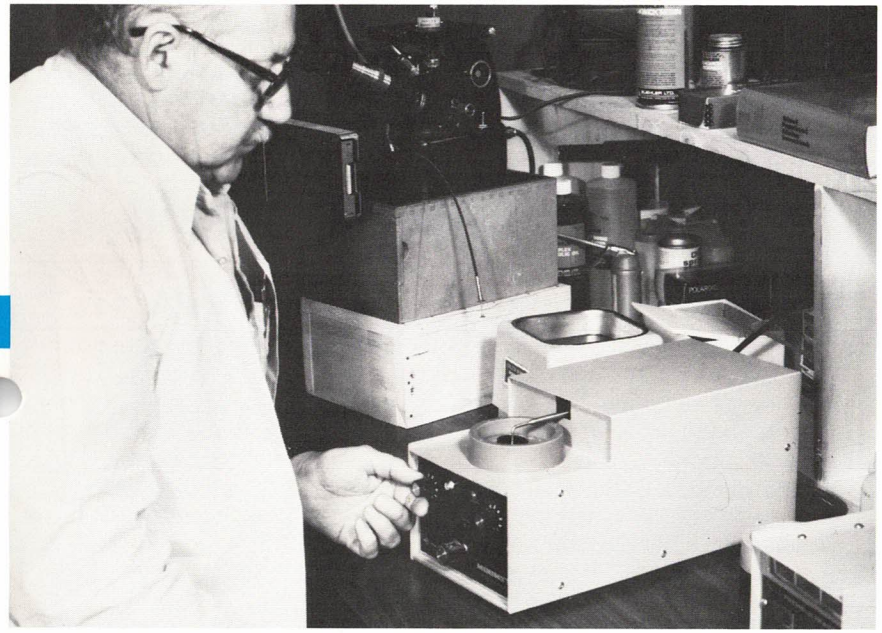


Figure 1. MINIMET® Polisher in Laboratory Use

In the past, metallography served the needs of the basic metals industry, and trends in metallographic development favored these applications. Primary steel producers, heavy metal fabricators, and large corporate R&D laboratories required heavy, floor standing equipment capable of preparing many specimens per day. Small fabricators, metal parts users, and those in other specialized industries frequently found this heavier equipment excessive for their needs. With preparation demands of only 2-5 specimens per day and significant limitation of space and funds, a more compact, economical approach to specimen preparation was needed. Increased pressure from consumer requirements and government safety standards encouraged many companies to consider the use of metallographic analysis procedures to meet these demands. The purchase and installation of heavy, expensive equipment was often an obstacle to the utilization of metallography by smaller companies.

Development of the MINIMET® was timely because it provided a tool that could meet the special requirements of light industry. With the MINIMET,® small numbers of well-polished specimens could be prepared in confined laboratory areas without extensive capital investment. The fully automatic features of this device permit relatively inexperienced operators to produce highly acceptable polished specimens. It is no longer necessary to hire specially trained metallographers to prepare specimens.

Although the MINIMET® was designed for routine metallographic specimen preparation, many new applications and ways to use this versatile instrument have been found. Resourceful metallographers soon discovered that attack polishing, electro-mechanical polishing and other special techniques could also be performed with the MINIMET.® In addition to conventional metallographic applications, the MINIMET® has found its way into many specialized industries such as electronics, ceramics, cement and others.

operating principles

The MINIMET® is shown in Figure 1 in a typical small laboratory installation. It employs a variably loaded arm (Figure 2) which moves the specimen in a unique geometric pattern (Figure 3) within a stationary polishing bowl. Abrasive paper or cloth is attached to a glass platen which rests on the bottom of the bowl and provides the surface needed to produce flat polished specimens. The bowl is held in place by means of a square protrusion on its underside which fits into a matching well on the polishing deck of the MINIMET®. A precisely located hole is drilled into the back of the sample to provide a means of linkage to the load arm.

Operating conditions are determined by the controls on the front panel of the MINIMET® as shown in Figure 4.

Speed: The traverse of the cyclic geometric action of the load arm is variable in speed from 1 to 9 (maximum) in arbitrary units with the Off-On Switch at 0.

Time: The duration of the polishing cycle is variable in arbitrary units from 1 to 9 with an automatic shutoff. Continuous untimed operation is obtained at the 0 setting.

Load: A variable load from 0 to 4 lbs. in two distinct modes, as shown in the inset of Figure 4, may be applied to the specimen.

When the knob is in the *Out* position and pointing upward, there is no load on the arm and it may be lifted to allow insertion or removal of the specimen.

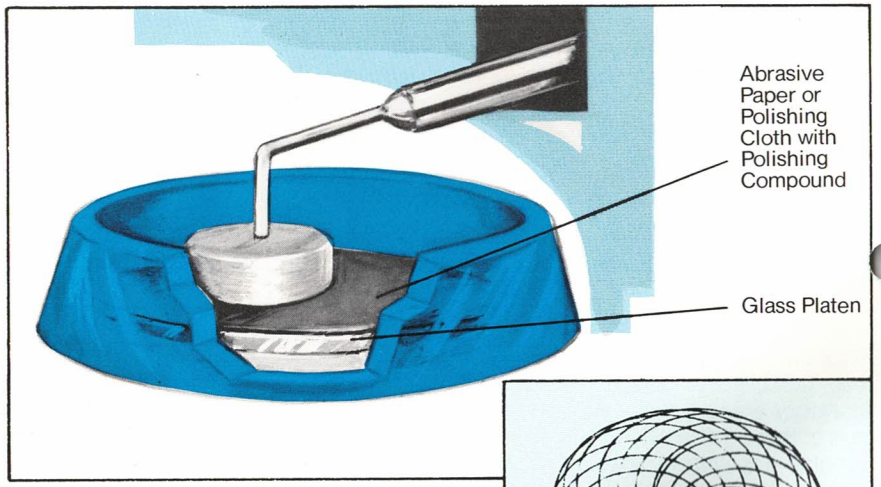


Figure 2. MINIMET® Load Arm and Bowl

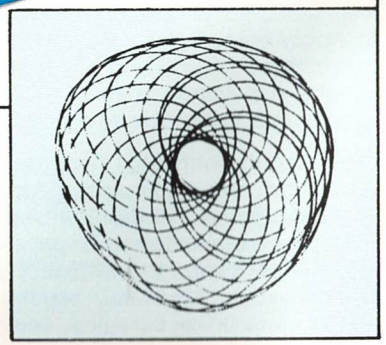


Figure 3. Pattern Produced by MINIMET® Polishing Action

In the *Center* position, increasing variable loads are obtainable by turning the knob clockwise. The load selected is maintained by detent increments. With the load knob *In* all the way, variable increasing loads are obtained by turning the knob in the clockwise direction. In this position, the load will automatically decrease as polishing proceeds. This feature is particularly useful in the final polishing step.

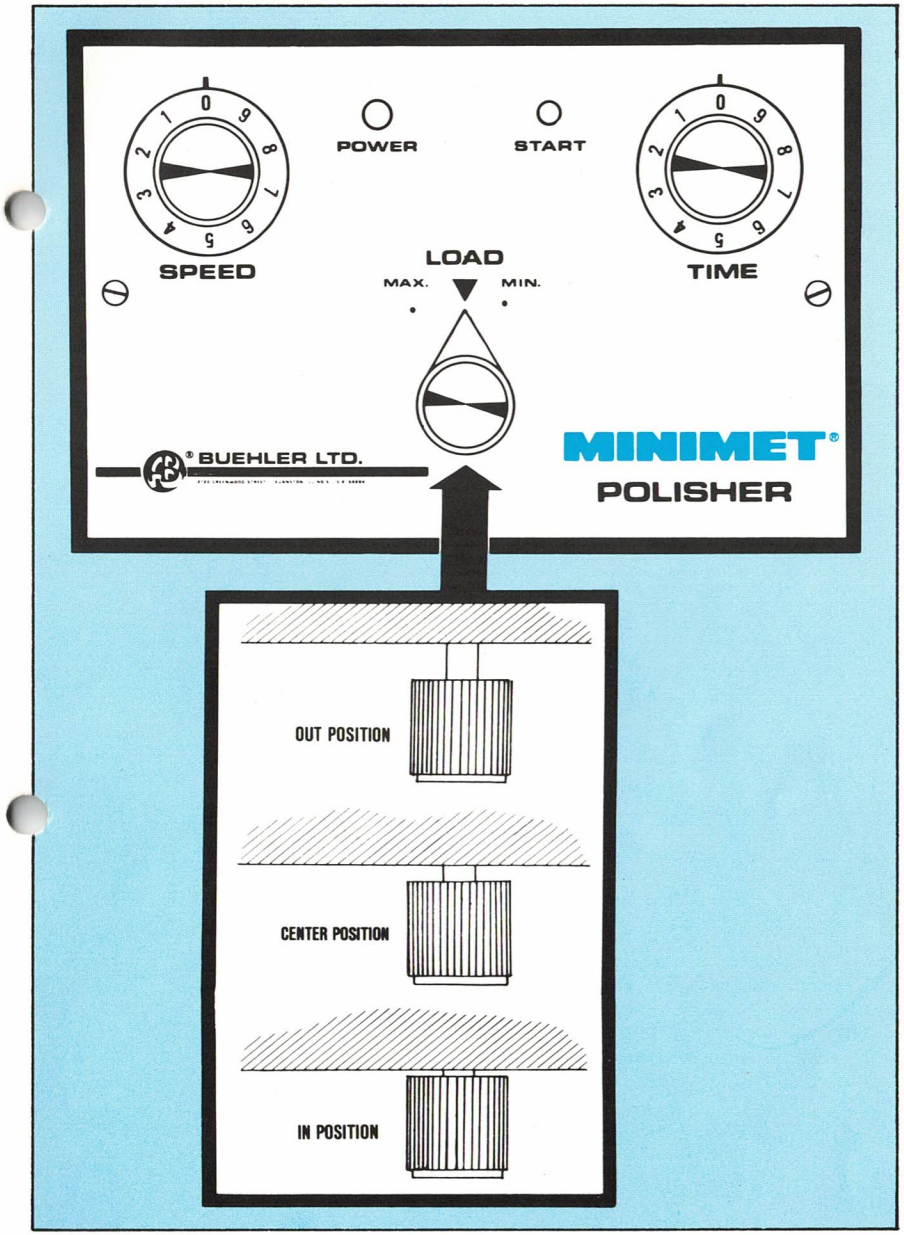


Figure 4. MINIMET® Control Panel

preparation prerequisites

Nearly any material which is polished with a rotating wheel polisher may be prepared on the MINIMET®. Large areas of extremely hard materials may require the use of a rotating wheel polisher if very heavy loads are necessary. The MINIMET® has been found to be superior to wheel polishers in certain applications where material removal rates must be closely controlled. A prime example is the preparation of printed circuit boards for examination of the plated through-holes.

MINIMET® results are best when the specimen is mounted in one of the standard encapsulant formats. Unmounted thin specimens may also be prepared. This is discussed later under Special Preparation Techniques. Standard encapsulated specimen sizes are: 1" (2.5cm), 1¼" (3.2cm), or 1½" (3.8cm) diameter. The height of the mount should be ⅝" (1.6cm) to 1" (2.5cm) to ensure correct loading. A 3/16" (0.5cm) diameter hole must be drilled into the center of the back of the mount to allow the tip of the load arm to properly seat. Correct depth and centering of the hole may be assured through use of the convenient Sample Alignment Fixture (69-1550). Although this device is offered as an accessory, its use is highly recommended. The Alignment Fixture is used in conjunction with an electrical hand drill as shown in Figure 5.

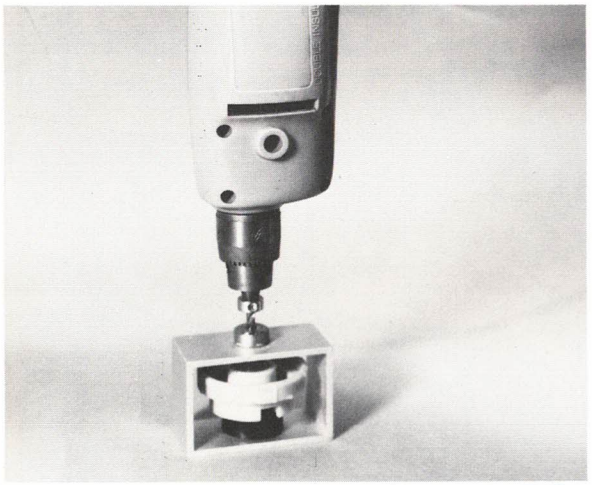


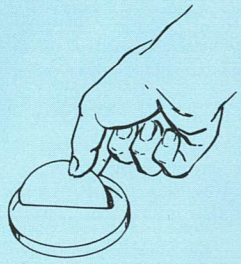
Figure 5. Alignment Fixture in Use with Portable Electric Drill

When mounted specimens are to be fine ground on the MINIMET®, a short, 120 grit belt grinding step may be needed to produce an initial flat surface. It is also advisable to bevel the sharp edges of the mount to prolong paper and cloth life.

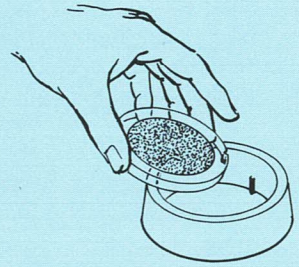
One of the unique features of the MINIMET® Polisher is the stationary bowl which contains the grinding and polishing media. The step-by-step procedure for preparing a bowl for operation is shown in Figure 6. To avoid use of the wrong abrasive and to prevent cross-contamination, the polishing bowls are color coded. One set of 3 (black, white and blue) is provided with the original unit. An additional set of 3 (yellow, red and green) is available if needed. To protect cloths from contamination between uses, convenient Storage Caddies (69-1502) are available.

preparation prerequisites

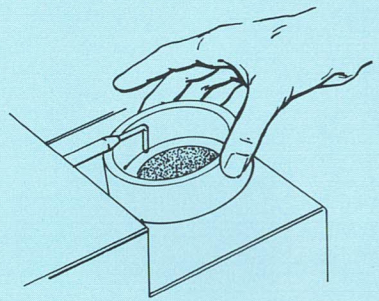
procedure for bowl preparation



(A) Apply adhesive-backed CARBIMET® grinding paper, Nylon, TEXMET® or MICROCLOTH® polishing cloth to the glass platen.

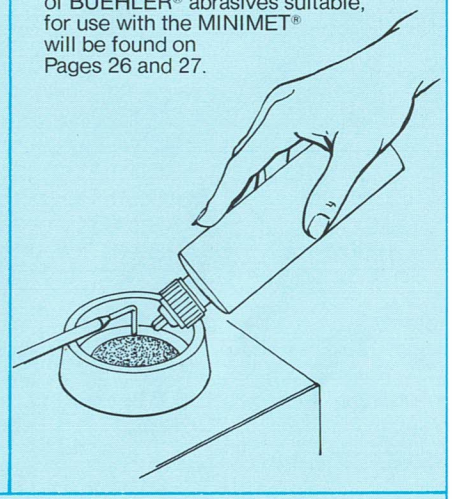


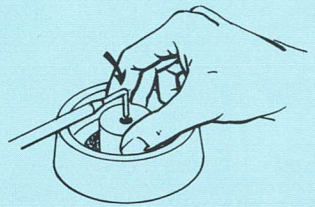
(B) Place glass platen into the bottom of the polishing bowl so that the notch of the platen keys with the index rib in the bowl.



(C) With the load knob at 0 position, lift the load arm and position the bowl so that it seats in the square detent in the polishing deck.

(D) Add abrasive materials and lubricants as required. A list of BUEHLER® abrasives suitable, for use with the MINIMET® will be found on Pages 26 and 27.





(E) Place specimen into the bowl and lower the point of the load arm into the hole provided in the back of the specimen.

(F) Set at least a partial load and adjust the speed and time knobs to the desired values.

(G) Press the start button. Load and speed, but not time, may be adjusted further during cycle if required.

Figure 6. Procedure for Bowl Preparation

PREPARATION PROCEDURES

The polishing steps employed with the MINIMET® Polisher are similar to those used with conventional rotary polishing wheels. It is immediately obvious that a large number of materials may be prepared using Sequence A, the simplest one.

As the materials become more difficult to polish, the sequence also becomes more complicated. Sequences B and C utilize additional Rough Polishing steps to prepare these harder materials.

Some materials are extremely difficult to prepare and require drastically different specimen preparation methods. The MINIMET® has shown a remarkable capacity for accommodation of special techniques needed to prepare certain materials. These special techniques are treated individually in the latter part of this METAL DIGEST®

sequence a. (For examples, see pages 9 and 10)

CARBON AND LOW ALLOY STEELS (NOT HEAT-TREATED), COPPER, BRASS, BRONZE, P.C. BOARDS, SOFT COMPOSITES

fine grinding

Abrasive/Size	Lap Wheel Covering	Lubricant	Load	Speed	Time
SiC, 240 grit	CARBIMET®	Tap Water	½-¾	5	5
SiC, 320 grit	CARBIMET®	Tap Water	½-¾	5	5
SiC, 400 grit	CARBIMET®	Tap Water	½-¾	5	5
SiC, 600 grit	CARBIMET®	Tap Water	½-¾	5	5

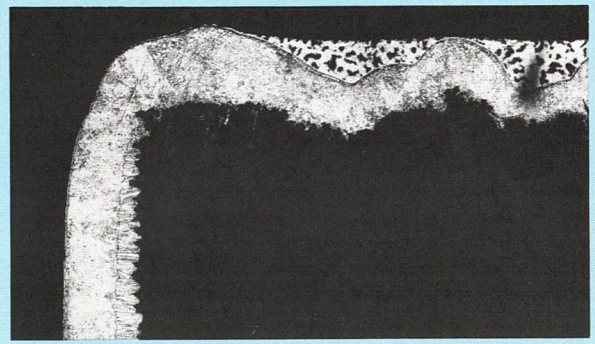
rough polishing

Abrasive/Size	Lap Wheel Covering	Lubricant	Load	Speed	Time
METADI® 6 micron	Nylon or TEXMET®*	AUTOMET® Lapping Oil	Full	4	5-7

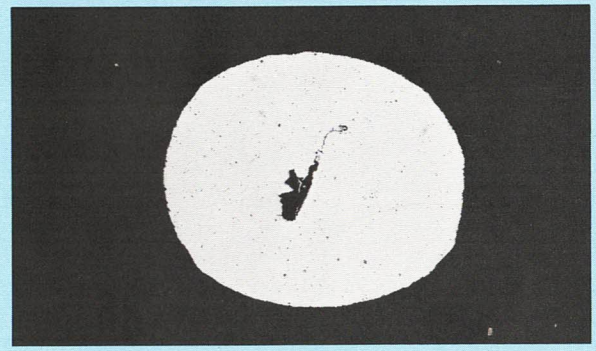
final polishing

Abrasive/Size	Lap Wheel Covering	Lubricant	Load	Speed	Time
Gamma Alumina 0.05 micron	MICROCLOTH®	Distilled Water	¾ and Decreasing	6-7	2-3

*TEXMET® is recommended for maximum flatness.



Printed Circuit Board
Mag.: 200X
Etchant: Ammonium Hydroxide (NH_4OH) Hydrogen Peroxide (H_2O_2)

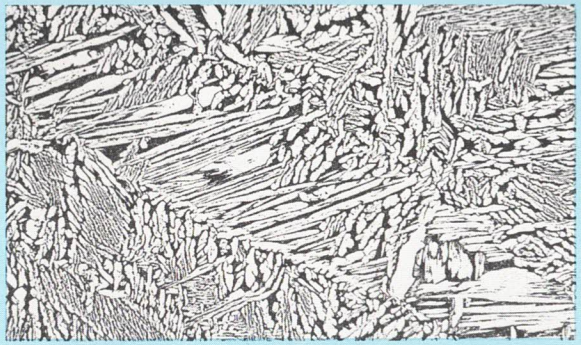


Steel Spring Wire with Center Defect
Mag.: 50X
Etchant: As Polished

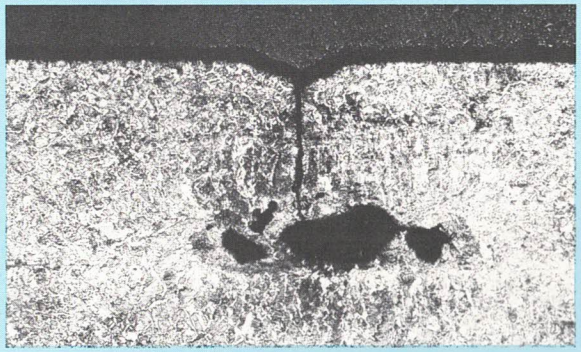
Gray Cast Iron
Mag.: 100X
Etchant: As Polished

50 Nickel-50 Iron
Mag.: 100X
Etchant: Nitric Acid (NHO_3)
Acetic Acid (CH_3COOH)

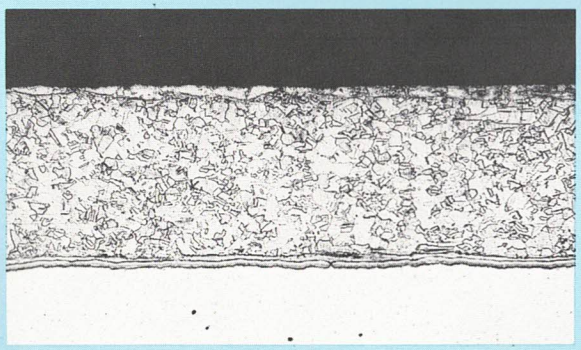
Steel Screw
with Thread Defect
Mag.: 100X
Etchant: As Polished



Aluminum Bronze
Mag.: 150X
Etchant: Potassium
($K_2Cr_2O_7$)



Steel Bicycle Rim Weld
Mag.: 50X
Etchant: 2% Nital



Copper-Aluminum
Composite
Mag.: 100X
Etchant: Ammonium
Hydroxide (NH_4OH)
Hydrogen Peroxide (H_2O_2)

sequence b. (For examples, see page 12)

HIGH ALLOY AND HARDENED STEELS, WHITE IRON, ALUMINUM, STAINLESS STEEL, MEDIUM HARD CERAMICS, SOME REFRACTORY METAL ALLOYS

fine grinding

Abrasive/Size	Lap/Wheel Covering	Lubricant	Load	Speed	Time
SiC, 240 grit	CARBIMET®	Tap Water	½	4	6
SiC, 320 grit	CARBIMET®	Tap Water	½	4	6
SiC, 400 grit	CARBIMET®	Tap Water	½	4	6
SiC, 600 grit	CARBIMET®	Tap Water	½	6	4

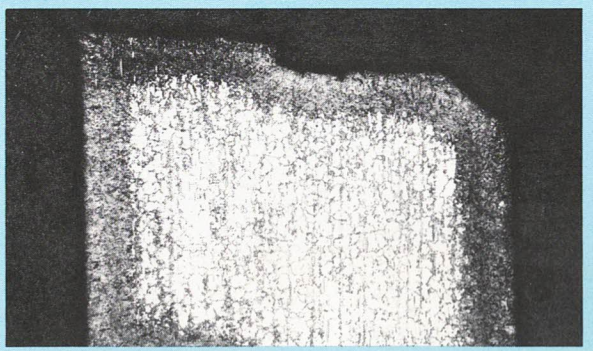
rough polishing

Abrasive/Size	Lap/Wheel Covering	Lubricant	Load	Speed	Time
METADI® 6 micron	Nylon or TEXMET®	AUTOMET® Lapping Oil	Full	5	7
METADI® 1 micron	Nylon or TEXMET®	AUTOMET® Lapping Oil	Full	5	7

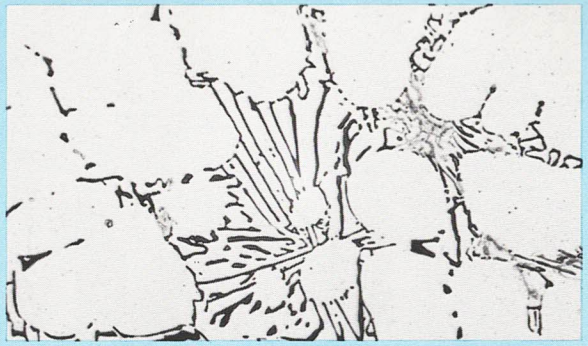
final polishing

Abrasive/Size	Lap/Wheel Covering	Lubricant	Load	Speed	Time
Gamma Alumina, 0.05 micron	MICROCLOTH®	Distilled Water	½	6	4

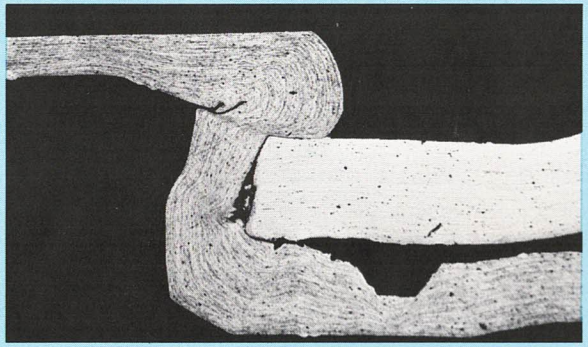
NOTE: Harder materials require two or more rough polishing steps as shown above. In some cases, it may be necessary to add an additional step consisting of 15 micron METADI® Compound on TEXMET® Perforated Cloth to completely remove all the fine grinding deformation.



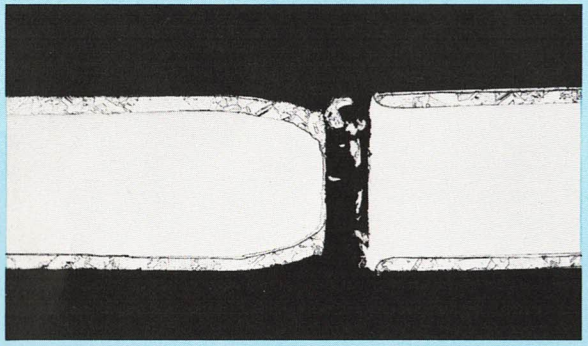
1020 Steel-
Case Hardened
Mag.: 50X
Etchant: 2% Nital



Cast Aluminum
Mag.: 200X
Etchant: As Polished



Aluminum Can Top
Upset Weld
Mag.: 50X
Etchant: Kellers



Electrical Resistor
with Contaminant Chips
Mag.: 50X
Etchant: Ammonium
Hydroxide (NH_4OH)
Hydrogen Peroxide (H_2O_2)

sequence c.

COMPLEX COMPOSITES SUCH AS INTEGRATED CIRCUITS AND OTHER SOLID STATE DEVICES

pre-preparation

- **Encapsulate in Epoxide Resin**
- **Section with ISOMET™ Saw**

fine grinding

Abrasive/Size	Lap/Wheel Covering	Lubricant	Load	Speed	Time
SiC, 400 grit	CARBIMET®	Tap Water	½-¾	5	5
SiC, 600 grit	CARBIMET®	Tap Water	½-¾	5	5

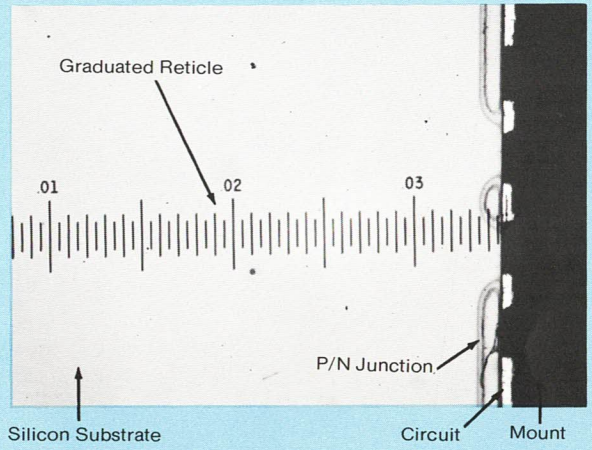
rough polishing

Abrasive/Size	Lap/Wheel Covering	Lubricant	Load	Speed	Time
METADI® 15 micron	TEXMET®	AUTOMET® Lapping Oil	Full	5	9
METADI® 6 micron	TEXMET®	AUTOMET® Lapping Oil	Full	5	9
METADI® 1 micron	TEXMET®	AUTOMET® Lapping Oil	Full	5	9

final polishing

Abrasive/Size	Lap/Wheel Covering	Lubricant	Load	Speed	Time
Gamma Alumina 0.05 micron	MICROCLOTH®	Distilled Water	¾ and Decreasing	6	3

Silicon Wafer
Solid State Device
Mag.: 800X
Etchant:
Acetic Acid (CH_3COOH)
Nitric Acid (HNO_3)
Hydrofluoric Acid (HF)



SPECIAL PREPRATION TECHNIQUES

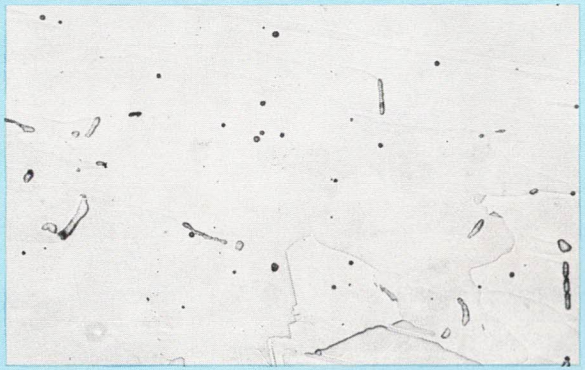
part I
attack polishing

Normal abrasive preparation often produces badly damaged layers in the polished surface rather than the desired undisturbed surface. Refractory metals such as Molybdenum and Tungsten typically exemplify this problem. In the case of soft metals and their alloys, difficulty is often encountered in the final removal of stratches. Attack polishing may also be used in these applications.

Attack polishing is the technique of adding an etching solution to one of the polishing steps, usually the final polishing solution. Working simultaneously with the abrasive particles, the etchant helps remove the damaged layers cleanly, resulting in a scratch free, undisturbed final polish.

Some attack polish solutions are given in Table I and photomicrographs of the surface they are able to produce are shown below. In most cases, the steps leading to the attack polishing steps are identical to normal preparation such as previously outlined (Sequences A and B). Therefore, only the composition of the attack polishing slurry is given. To prevent etching of the structure, the specimen must be removed immediately upon completion of this step.

CAUTION: TONGS MUST BE USED TO HANDLE THE SPECIMEN AND IT IS ESSENTIAL THAT RUBBER GLOVES BE WORN WHEN HANDLING THE BOWL CONTAINING THE ATTACK SLURRY.



Silicon Substrate
Mag.: 100X
Etchant: Attack Polished

Lead/Antimony Alloy
Mag.: 500X
Etchant: Attack Polished

table I
typical attack polishing slurries

SAMPLE MATERIAL	SLURRY COMPOSITION	POLISHING CLOTH
COPPER BASE ALLOYS	10 VOL % in Distilled Water (H_2O), Ferric Nitrate ($Fe(NO_3)_3$) 15.0 g MICROPOLISH® Alumina B	MICROCLOTH®
LEAD ALLOYS	40.0 ml Acetic Acid (CH_3COOH) 10.0 ml Hydrogen Peroxide (H_2O_2)—3% 10.0 ml Glycerine ($HOCH_2CHOHCH_2OH$) 15.0 g MICROPOLISH® Alumina B	MICROCLOTH®
LEAD AND TIN BASE ALLOYS	30.0 ml Distilled Water (H_2O) 5.0 ml Hydrochloric Acid (HCl) 3.0 g Ferric Chloride ($FeCl_3$) 15.0 g MICROPOLISH® Alumina B	MICROCLOTH®
TUNGSTEN, MOLYBDENUM	80.0 ml Distilled Water (H_2O) 15.0 ml Nitric Acid (HNO_3) 3.0 ml Hydroflouric Acid (HF)* 15.0 g MICROPOLISH® Alumina B	MICROCLOTH®
TUNGSTEN AND TITANIUM	75.0 ml Distilled Water (H_2O) 1.0 g Chromic Acid (CrO_3) 15.0 g MICROPOLISH® Alumina B	MICROCLOTH®
TI-3A1-2V	95.0 ml Distilled Water (H_2O) 3.5 ml Nitric Acid (HNO_3) 1.5 ml Hydroflouric Acid (HF)* 15.0 g MICROPOLISH® Alumina B	MICROCLOTH® MICROCLOTH®
SILICON	50.0 ml Distilled Water (H_2O) 25.0 g Sodium Hydroxide (NaOH) 10.0-12.0 g MICROPOLISH® Alumina B	CHEMOMET®

**CAUTION: EXERCISE EXTREME CARE IN HANDLING—USE SAFETY GLASSES AND CHEMICAL GLOVES.*

part II
electro-mechanical polishing

There are certain metallographic applications where simple attack polishing is not completely effective. It is known that the application of a DC voltage between dissimilar metals, in contact with a chemical electrolyte, will remove metal by anodic dissolution at a favorable rate similar to electrolytic etching. When this procedure is combined with the mechanical cutting action of fine abrasives, an accelerated material removal system is produced. This electro-mechanical polishing systems has been particularly effective for Tungsten, Molybdenum and other refractory metals and alloys.

The unique configuration of the MINIMET® Polisher allows a simple adaption of the unit to produce the electro-mechanical polisher illustrated in Figure 7. It is recommended that the 69-1570 MINIMET® Electro-Mechanical Attachment be installed on the MINIMET® for electro-mechanical polishing. Specifically, the Red Lead is clamped onto the MINIMET® Load Arm, and the Black Lead is attached to the Platen Terminal. A suitable electrolyte is carefully selected from Table II on page 17 and the appropriate ratio of abrasives should be added.

Actual times, voltage and electrolyte strengths must be determined by trial for each sample due to variation in sample size and composition. The sample must be washed immediately after the polishing procedure has been completed to preserve the polished surface.

Figure 7. MINIMET® Polisher with 69-1570 Electro-Mechanical Attachment for Polishing Difficult Materials

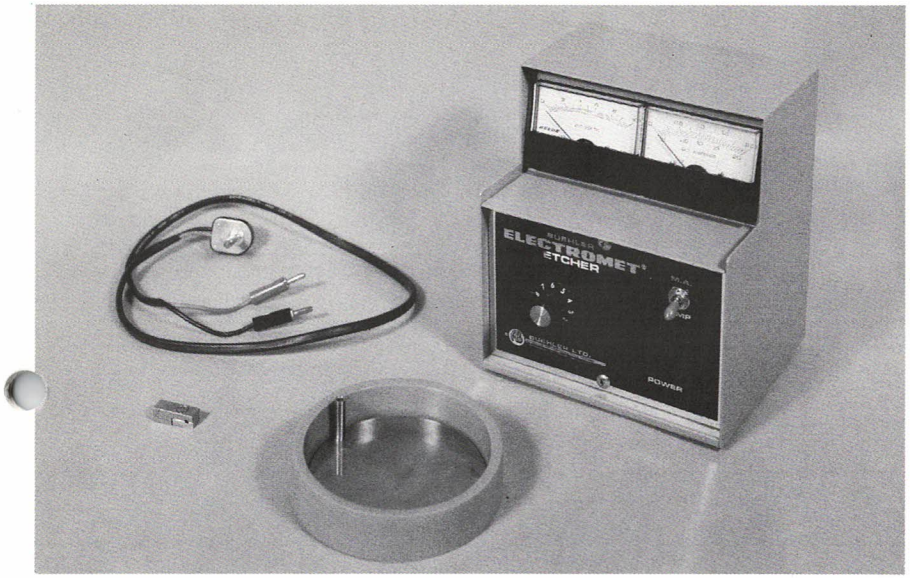
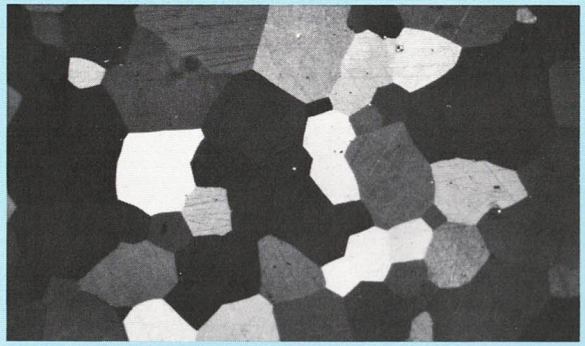


Figure 8. Components of the Electro-mechanical Attachment

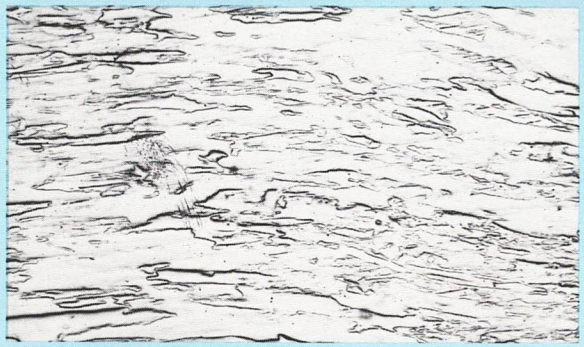
table II
typical electro-mechanical slurries

SAMPLE MATERIAL	SLURRY COMPOSITION	ELECTRICAL SETTING
BERYLLIUM ALLOYS	97 ml Ethylene Glycol ($C_2H_6O_2$) 2 ml Nitric Acid (NHO_3) 1 ml Hydrochloric Acid (HCl) 30 g MICROPOLISH® Alumina B	4-6 V. DC
MOLYBDENUM ALLOYS	100 ml Distilled Water (H_2O) 10 g Sodium Hydroxide (NaOH) 30 g MICROPOLISH® Alumina B	9-10 V. DC
TUNGSTEN (FILAMENTS), MOLYBDENUM	100 ml Distilled Water (H_2O) 10 ml Potassium Ferrocyanide-Saturated Solution ($K_4Fe(CN)_6$) 30 g MICROPOLISH® Alumina B	10 V. DC
NIOBIUM	300 ml Distilled Water (H_2O) 30 ml Hydrogen Peroxide-30% (H_2O_2) 30 g MICROPOLISH® Alumina B	1-10 MA/CM²

CAUTION: EXERCISE EXTREME CARE IN HANDLING—USE SAFETY GLASSES AND CHEMICAL GLOVES.



Beryllium Alloy
Mag.: 50X
Etchant: As Polished
(Polarized Light)



Tungsten
Mag.: 50X
Etchant: As Polished

Molybdenum Honeycomb
Mag.: 50X
Etchant: As Polished

Refractory Thin Section
Mag.: 200X
Etchant: As Polished.
(Polished on the MINIMET®
with the Thin Section
Attachment as shown in
Figure 9, page 19.)

part III
thin section specimen preparation

An important technique for analyzing nonmetals, such as cement clinkers, rocks and minerals, is the examination of a thin specimen by transmitted polarized light. This technique is widely used, but difficult to master when performed manually. Successful analyses require uniformly thinned slices (about 30 microns thick) of the material. To minimize the labor and skill needed, a semi-automatic specimen preparation method has been developed which utilizes the MINIMET® Polisher/Grinder. To attach the specimen to the MINIMET,® the 69-1580 Thin Section Attachment must be used (Figure 9).

Figure 9. MINIMET® Polisher with the 69-1580 Thin Section Attachment

part IV
precision thinning for ion micromilling and other applications

Ceramic materials for electron microscopy must be thinned to produce a perforation in a manner similar to that used to prepare metal specimens. Since ceramics are nonconductive, electrolytic jet thinning, commonly used to prepare metallic specimens, cannot be used. Instead, a special ion micromilling device must be employed to obtain the required perforation. First, a small disc is thinned by a manual abrasive technique to 100 microns thickness or less. With this thickness, ion micromilling times often exceed twenty hours. Specimens prethinned manually are not always of uniform thickness, and may reveal erratic results in the ion micromilling process.

Figure 10. MINIMET® Polisher with the 69-1560 Precision Thinning Attachment used for Plano-parallel Polishing

The MINIMET® Precision Thinning Attachment (69-1560) shown in Figure 10 (adapts only to MINIMET® Polishers where last digits of serial number are MN4213 and above) effectively reduces ion micromilling times by prethinning nonmetallic specimens to a uniform thickness of 40 microns or less. When precision thinned specimens are placed into the ion micromilling device, uniform perforated specimens are prepared in 3-7 hours. This procedure generally achieves results that are more consistent, with larger observable areas than those produced by manual techniques.

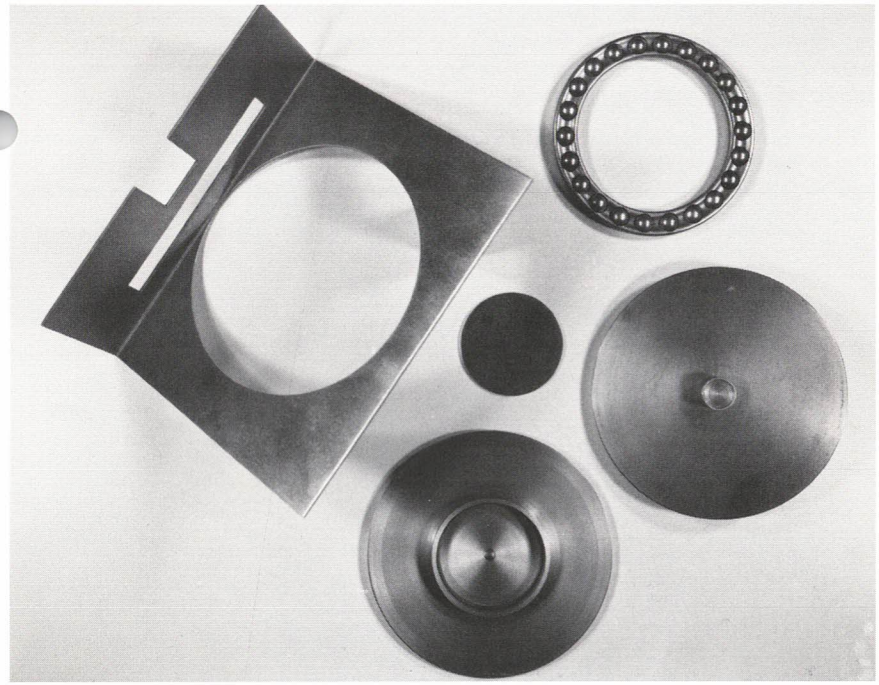


Figure 11. Components of Precision Thinning Attachment

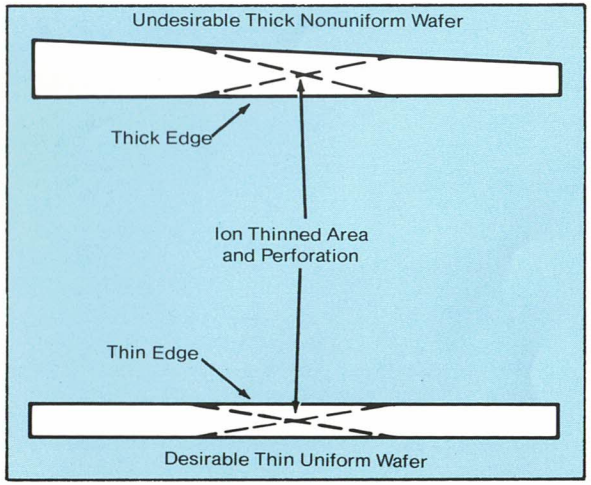


Figure 12. Effect of Prethinning Geometry on Resultant Ion Thinned Area

part V
wafer polishing

Metallographic specimens prepared on rotary polishers are ⅛" or more in thickness and are mounted in an encapsulant. Because MINIMET® specimen preparation requires a hole in the back of the mount, specimens for mounting should be limited to ¼" high.

When it is necessary to polish strips thinner than ⅛" (3.18mm), conventional encapsulation may be impossible. If preparation of unmounted pieces is desired, use of the 69-1590 Wafer Polishing Attachment is necessary. In addition to providing a means of attaching the Specimen to the load arm, the required height adjustment is supplied.

Figure 14 shows a thin metal strip which has been attached to a Wafering Block with 40-8100 Lakeside Thermoplastic Cement. This cement melts at 285°F (140°C) and hardens on cooling. To remove the specimen from the Wafering Block, simply reheat and slide the specimen from the face of the Block.

Figure 13. MINIMET® Polisher with the 69-1590 Wafer Polishing Attachment

The METAL DIGEST® Volume 12/13, No. 1., polishing procedures for Petrographic and Ceramographic transmitted and reflected light sections, is available on request and may be helpful in the preparation procedures described in this issue of METAL DIGEST®:

Related Research and Technical Reports, listed on the back cover, may also be of interest.

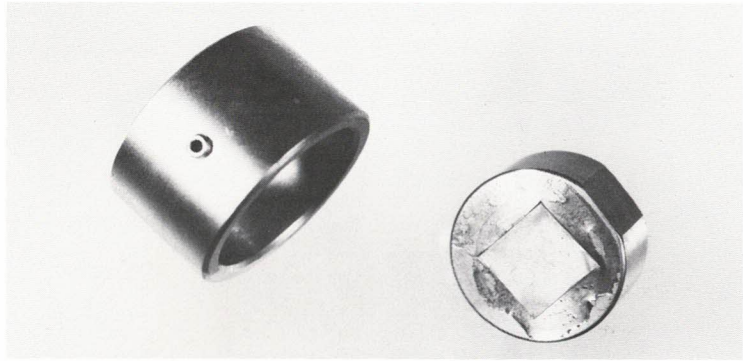
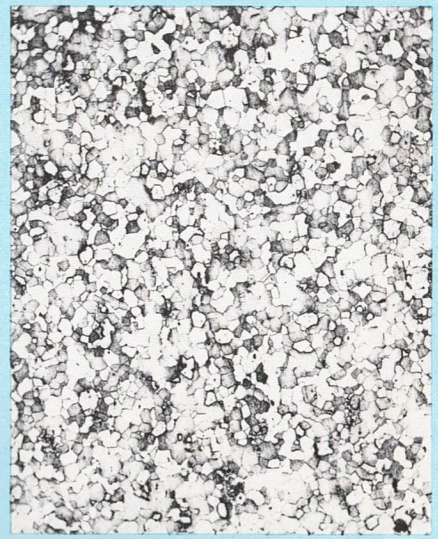


Figure 14. Components of the 69-1590 Wafer Polishing Attachment (with metal strip attached to Wafering Block)

Commercially Pure Nickel
Mag.: 200X
Etchant: 50 ml Acetic Acid (CH_3COOH)
50 ml Nitric Acid (HNO_3)



Low Carbon Steel
Mag.: 100X
Etchant: 2% Nital

MINIMET®
specifications and accessories

specifications

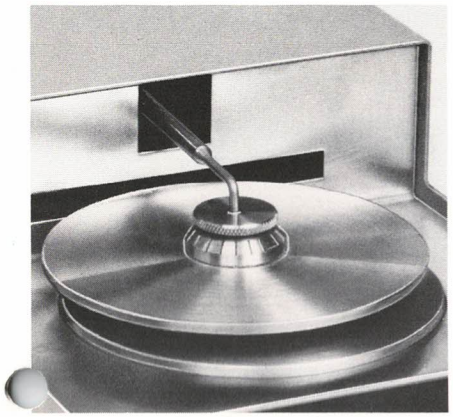
No. 69-1000 MINIMET® POLISHER/GRINDER, with on-off switch, variable load control, automatic load reduction control, variable speed control, automatic timer and pilot light. For 115 V., 60 Hz., 1 ϕ. Complete with three polishing bowls (1 ea. black, white, blue), three glass platens. Samples of CARBIMET® paper and polishing cloth. Operating instructions.

Overall dimensions: 7"Wx16"Dx8"H
(18x40x20 cm)

Approximate shipping weight: 25 lbs. (11 kg)

accessories

No. 69-1500 POLISHING BOWLS (Set of 3), 1 ea. black, white, blue.
No. 69-1501 POLISHING BOWLS (Set of 3), 1 ea. yellow, green, red.
No. 69-1502 STORAGE CADDIES (Set of 3), for Polishing bowls.
No. 69-1510 GLASS PLATENS (Set of 3), replacement.
No. 69-1550 SAMPLE ALIGNMENT FIXTURE, with 3 drill bits.
No. 69-1552 DRILL BITS (Set of 3), replacement.



69-1560 Precision Thinning Attachment

69-1570 Electro-Mechanical Attachment

69-1580 Thin Section Attachment

69-1590 Wafer Polishing Attachment

accessories (continued)

No. 69-1560 MINIMET® PRECISION THINNING ATTACHMENT, with special face plate, upper platen with micrometer adjustment, lower platen and bearing race. Operating instructions.

No. 69-1570 MINIMET® ELECTRO-MECHANICAL ATTACHMENT, with bowl, anode and cathode connectors and 10 volt ELECTROMET® Power Supply for 115 V., 60 Hz., 1 ϕ. Operating instructions.

No. 69-1580 MINIMET® THIN SECTION ATTACHMENT, with three thin section bowls (1 ea. black, white, blue), three glass platens and slide holder for 27x46mm slides. Operating instructions.

No. 69-1581 THIN SECTION BOWLS (Set of 3), 1 ea. black, white, blue.

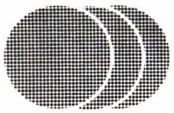
No. 69-1582 THIN SECTION GLASS PLATENS (Set of 3), replacement.

No. 69-1583 MINIMET® THIN SECTION SLIDE HOLDER, for 27x46mm slides.

No. 69-1590 MINIMET® WAFER POLISHING ATTACHMENT, with adjustable thickness control for 1" (2.5cm) diameter wafers. Operating instructions.

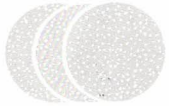
Available for operation on other electrical services.

MINIMET®
supplies



CARBIMET® PAPER DISCS (PSA BACKED)

2⅞" Dia. (7.3cm)	Grit	Quantity
30-5170-180-100	180	100
30-5170-240-100	240	100
30-5170-320-100	320	100
30-5170-400-100	400	100
30-5170-600-100	600	100
30-5178-180	Asst.	50 (10 ea. grit)



POLISHING CLOTHS (PSA BACKED)

Catalog No.	Description
40-7052	Nylon, 2⅞" (7.3cm) dia. PSA back
40-7212	MICROCLOTH,® 2⅞" (7.3cm) dia. PSA back
40-7602	TEXMET,® 2⅞" (7.3cm) dia. PSA back
40-7662	TEXMET,® 2⅞" (7.3cm) dia. perf. Chem. (MEK) activated adh back

(Packaged 20 per box)

POLISHING OXIDES

Micron/ Type	Powder 1 lb. (0.45 kg)	Powder 5 lbs. (2.3 kg)	Suspension 6 oz. (0.18 l)
5.0 Al_2O_3			40-6351-006
1.0 Al_2O_3(C)	40-6310-016	40-6310-080	40-6354-006
0.3 Al_2O_3(A)	40-6305-016	40-6305-080	40-6352-006
0.05 Al_2O_3(B)	40-6301-016	40-6301-080	40-6353-006
1.0 CeO			40-6355-006
1-5 Cr_2O_3	40-6480-016	40-6480-080	
1.0 Cr_2O_3			40-6481-006
0.5 Cr_2O_3			40-6482-006
MgO	40-6440-016		
3.0 Fe_2O_3	40-6445-016	40-6445-080	

Al_2O_3 Types "A," "B," "C" powders also available in 4 ounce and 8 ounce sizes.

METADI® DIAMOND COMPOUNDS

PASTE 5 Grams	PASTE 20 Grams	MICRON	COLOR	AEROSOL SPRAY 5 oz. (142g)
40-6112	40-6102	¼ Medium	Gray	40-6260
40-6132	40-6122	1 Medium	Blue	40-6264
40-6138	40-6128	1 Heavy	Blue	
40-6152	40-6142	3 Heavy	Green	40-6268
40-6172	40-6162	6 Medium	Yellow	40-6272
40-6192	40-6182	9 Heavy	Deep Red	40-6276
40-6212	40-6202	15 Heavy	Brown	40-6280
40-6222		30 Medium	Mahogany	40-6284
40-6232		45 Medium	Purple	40-6288

METADI® II DIAMOND COMPOUNDS

MICRON	COLOR	PASTE 5 Grams	PASTE 20 Grams
¼	Gray	40-6241	40-6240
1	Blue	40-6244	40-6243
3	Green	40-6247	40-6246
6	Yellow	40-6250	40-6249
9	Deep Red	40-6253	40-6252
15	Brown	40-6256	40-6255
30	Mahogany	40-6258	
45	Purple	40-6259	

EXTENDERS FOR METADI®

Catalog No.	Description
40-6004	METADI® Fluid 4 oz. (0.12/) with applicator
40-6014	METADI® Fluid 4 oz. (0.12/) Refill
40-6016	METADI® Fluid 16 oz. (0.47/) Refill
40-6032	METADI® Fluid 32 oz. (0.95/) Refill
40-3200	Atomizer Applicator for METADI® Fluid
40-8140-032	Mineral Spirits 32 oz. (0.95/)
40-8140-128	Mineral Spirits 1 gal. (3.8/)
40-8142-032	Polishing Oil 32 oz. (0.95/)
40-8142-128	Polishing Oil 1 gal. (3.8/)
60-3250-006	AUTOMET® Lapping Oil 6 oz. (0.18/)
60-3250-128	AUTOMET® Lapping Oil 1 gal. (3.8/)
60-3255	Applicator Bottle 8 oz. (0.24/)