

# ALLIED

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### MultiPrep™ Procedure

#### **Backside Thinning of a Flip-Chip Device**

G. D. Liechty, C. A. Smith, Allied High Tech Products, Inc., August 2003

#### **Overview**

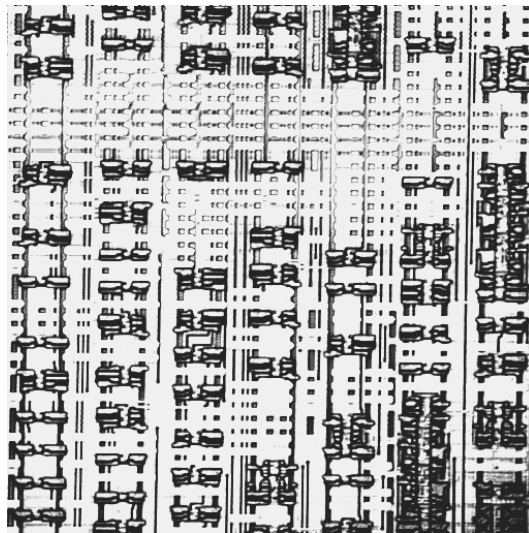
When thinning electronic devices for various analyses, including SIMS, LSM, Backside Emission Microscopy and related NIR techniques, it is important to achieve a flat, highly polished surface.

The MultiPrep™ automatically indexes samples into the abrasive, eliminating the need to hand-hold polishing jigs.

This allows for unattended sample preparation, enabling the user to perform other lab tasks simultaneously. IC's or packages such as flip chip, DIP, BGA or PBGA can be prepared, maintaining electrical properties necessary for fault isolation and analysis. Even packages with recessed silicon

below the lead frame can be globally polished and rewired before analysis.

In this procedure, a flip-chip device will be mounted to a calibrated polishing fixture. The device will then be polished to a thickness of approximately 100 microns, and prepared for observation in an emission microscope.



It is strongly recommended that the MultiPrep™ System manual be studied to ensure familiarity with the terms used to describe certain functions and components in this procedure.

Consumable selection, machine settings and techniques used in this procedure were developed using the MultiPrep™ System in Allied's applications laboratory.

## Equipment Used:

15-2000	MultiPrep™ System
10-1005	Platen (1 for each cloth used)
15-1020	Parallel Polishing Fixture
15-1035	Weight Kit
120-30010	Dial Indicator Measurement System
120-30020	Mount Leveling Press
15-Indicator	(Optional, See Back Page)

Zeiss Axioskop 2 MAT Compound Microscope  
Zeiss Stemi DV-4 Stereomicroscope

**Note:** Part numbers for microscopes depend on desired configuration.

## Consumables Used:

71-10040	Hot Mounting Wax
50-30040	30µm Diamond Lapping Film (DLF)
50-30045	15µm Diamond Lapping Film
50-30055	6µm Diamond Lapping Film
50-05518	Rubber Squeegee
90-150-005	Kempad Polishing Cloth
90-30025	6µm Diamond Suspension
90-150-350	Red Final C Polishing Cloth
90-30015	1µm Diamond Suspension
90-207010	RedLube™ Diamond Extender
180-10050	Chem-Pol Polishing Cloth
180-20000	0.05µm Non-Crystallizing Colloidal Silica Suspension
148-10000	Micro Organic Soap
210-30000	Cotton-Tipped Applicators/Swabs
50-30000	DLF Storage/Blotter Book
200-20000	Aero-Duster

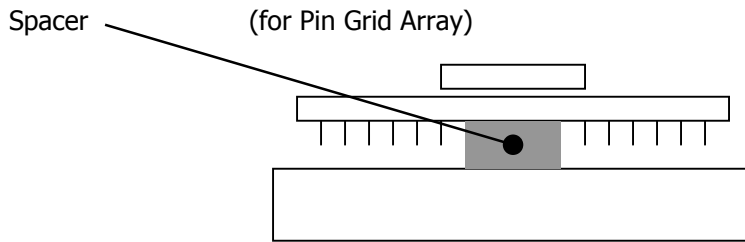
## Other:

Hot Plate with Digital Temperature Readout  
Acetone  
Isopropyl Alcohol  
Tweezers  
Filter Paper  
Glass Beakers

## Procedure

1. Calibrate the MultiPrep™ System according to the procedures in the manual.
2. Place the parallel polishing fixture that was used for calibration onto the hot plate and heat to 175° C.
3. Melt a sufficient amount of wax onto the surface of the fixture.

**Note:** Depending on the type of flip-chip (i.e. pin or ball grid) a spacer may be needed so the pins or solder balls do not interfere with adhesion of the device to the fixture (see figure 1). This only applies to samples that have center areas where there are no pins or solder balls. Special fixtures can be made to accommodate other types of packages.



**Figure 1**



**Photo 1**

If mounting a ball grid array, the wax will need to be thick so it can form around the solder balls to improve adhesion. If this is necessary, only heat the hot plate to 125° C.

4. Place the device onto the fixture (silicon side up) and position it in the center.
5. Remove the fixture from the hot plate and place it onto the mount leveling press.

**Note:** The mount leveling press is used to orient the backside of the die parallel with the fixture. Since the die may not be oriented parallel with the package geometry, the leveling press will help compensate for this.

6. Put a piece of filter paper over the silicon so the press plunger does not stick to the device and wax. Apply the plunger to the device and compress the wax between the sample and the fixture using moderate pressure so as not to crack the die (see photo 1). The wax will form to the uneven surfaces and cool/adhere to the sample and fixture. Allow approximately 10 minutes at room temperature for the wax to harden.
7. Place the fixture onto the dial indicator measurement system with the die facing the indicator spindle (see photo 2).
8. Lower the indicator spindle onto the silicon and zero the display.
9. Lift the spindle and remove the fixture from the measurement device.
10. Swing the MultiPrep™ arm away from the platen.



**Note:** Polishing rates will vary depending on the surface area, load, abrasive size and abrasive condition (new vs. used). This documented procedure is based on polishing a die measuring 144mm<sup>2</sup>. The following table provides recommendations on time and pressure as well as steps to be used for various device sizes:

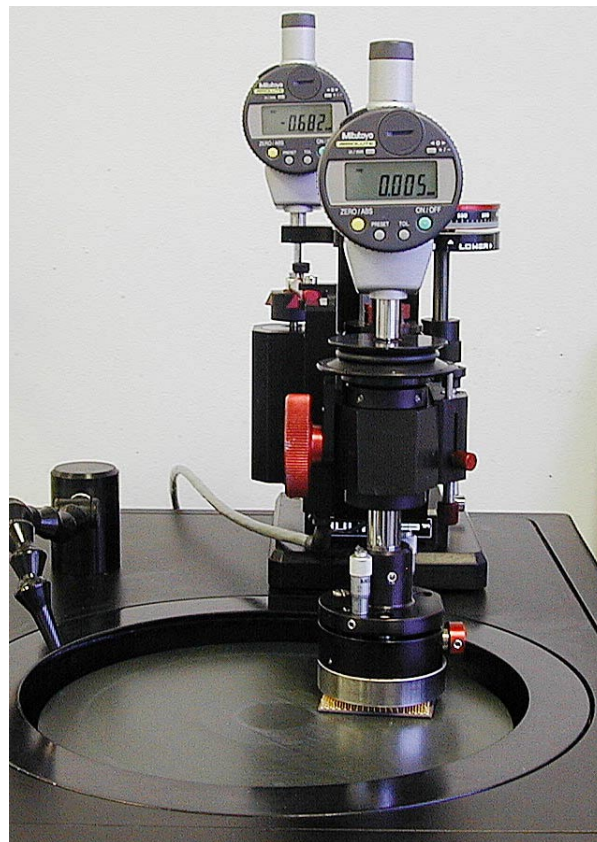
<b>Device Size (Approx.)</b>	<b>Time*</b>	<b>Load</b>	<b>Start w/ (µm) DLF</b>
20mm <sup>2</sup>	3 min.	200 grams	15 µm DLF**
36mm <sup>2</sup>	3 min.	300 grams	15 µm DLF**
81mm <sup>2</sup>	4 min.	500 grams	15 µm DLF**
144mm <sup>2</sup>	4 min.	Full	30 µm DLF

\* applies to polishing cloths, each step  
 \*\* stop instead at 105-110 microns thick

11. Secure a 30µm DLF to the platen using the rubber squeegee.
12. Position the arm by connecting the oscillator linkage.
13. Attach the fixture to the MultiPrep™.

**Photo 2**

14. Set the oscillation range between ½ to 1 inch so the edges of the sample are confined to the radius of the platen (from center to edge). Set the oscillation speed to "3".
15. Set sample rotation speed to "3".
16. Activate platen rotation clockwise at 150 RPM.
17. Activate coolant, sample rotation and oscillation.
18. Lower the spindle riser (if raised), making sure the sample does not make contact with the abrasive.
19. Zero the dial indicator.
20. Using the vertical adjustment knob, lower the sample into the abrasive until the dial indicator reads between 50 to 75 microns. Polish until the spindle pulley rests on the arm (mechanical stop) and no more material is being removed (see photo 3).



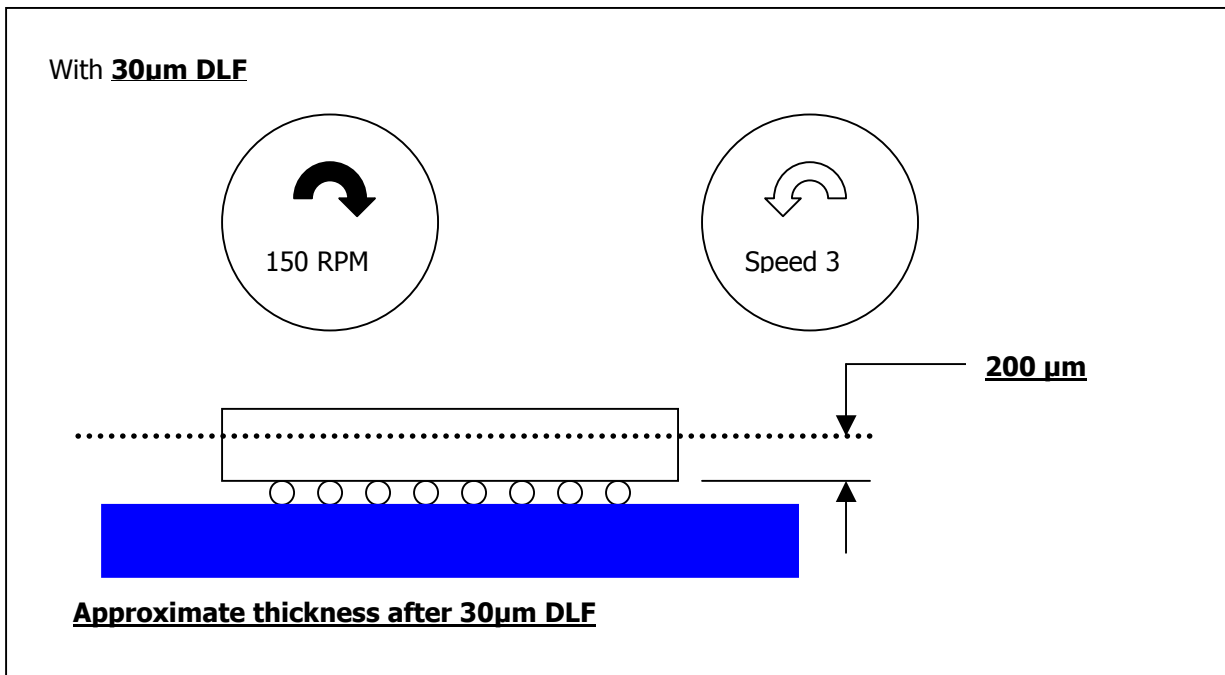
**Photo 3**

21. Stop the machine and lift the sample using the spindle riser. The spindle riser allows the mechanical stop position to remain intact and be used when the sample is placed back into position.

**Note:** By removing only a few microns from the device, alignment can also be verified. Use the micrometer heads to align an unparallel sample.

22. Measure the device on the measurement system to determine how much silicon has been removed.

23. Using the vertical adjustment knob, lower the arm to remove all but approximately 200 microns from the device (see figure 2). For example, if the sample thickness equals 590 microns, lower the arm approximately 390 microns. **Note:** If the resolution of the vertical adjustment knob dial is too difficult to read, the dial indicator attachment (#15-Indicator) may be installed as an option (see back page).



**Figure 2**

24. Attach the fixture and activate platen rotation.

25. Activate coolant, sample oscillation and rotation.

26. Using the spindle riser, lower the sample onto the abrasive and polish until the spindle pulley rests on the arm (mechanical stop) and no more material is being removed. **Note:** To increase the polishing rate on larger devices, the 200-gram slotted weight may be used, placed onto the spindle pulley below the dial indicator (see photo 4). As die size varies, so will the polishing rate.

27. Once finished, swing the MultiPrep™ arm away from the platen.

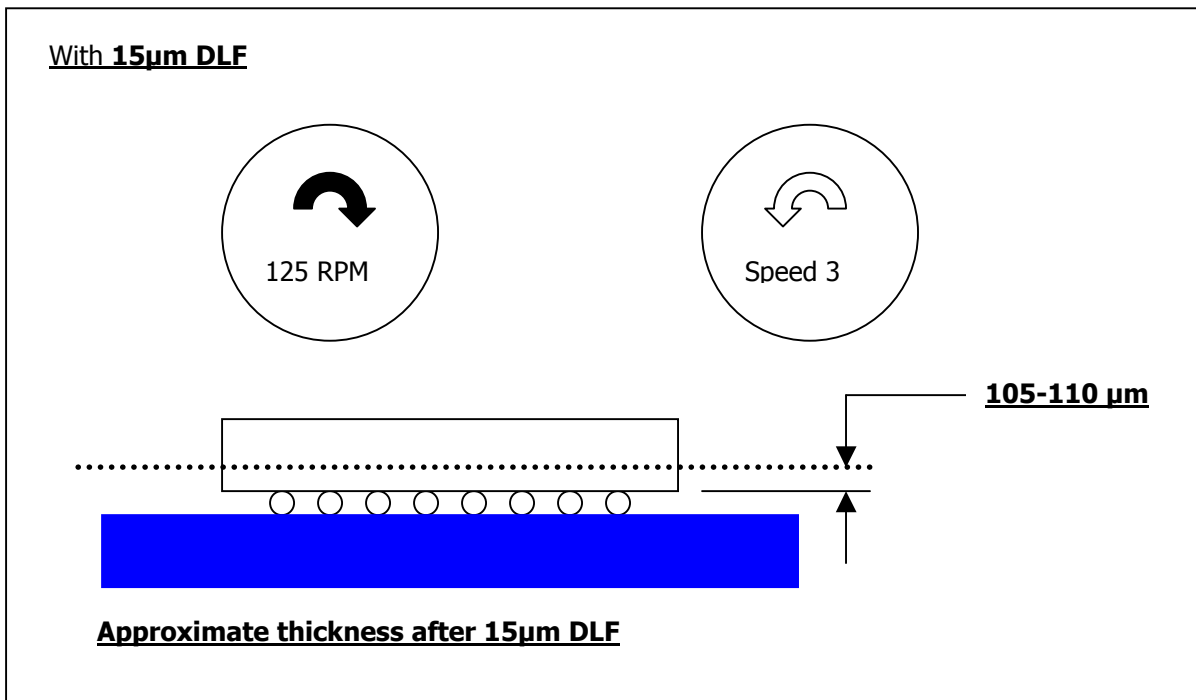
28. Remove the fixture and clean the sample using a soft bristled brush (a toothbrush works well) and Micro Organic Soap mixed 1:10 with water, then dry using clean air such as an Aero-Duster.

**Note:** It is VERY important the sample be thoroughly cleaned between each step to eliminate or reduce scratches and contamination. See "Notes" at the end for more information regarding scratches.



**Photo 4**

29. Measure and record the sample thickness.
30. Secure a 15 $\mu$ m DLF to the platen.
31. Position the arm by connecting the oscillator linkage.
32. Attach the fixture and activate platen rotation clockwise at 125 RPM.
33. Activate coolant, sample oscillation and rotation.
34. Lower the sample with the spindle riser.
35. Zero the dial indicator and lower the arm with the vertical adjustment knob so the display reads between 20 to 40 microns.
36. Polish the sample until the spindle pulley rests on the arm and no more material is being removed.
37. Stop the machine, raise the sample with the spindle riser, remove the fixture, clean and measure the die thickness.
38. Attach the fixture and lower the arm to allow all but approximately 105 to 110 microns to be removed from the sample (see figure 3).
39. Activate coolant, sample oscillation and rotation. **Note:** The rate of polish will again vary depending on condition of the film but should not take longer than about 5 minutes.
40. Remove the fixture and clean the sample thoroughly. Measure the thickness of the sample. If additional removal is required, continue using step 38 until the sample is thinned to about 5 to 10 microns from the target area.

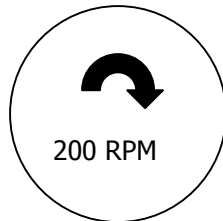


**Figure 3**

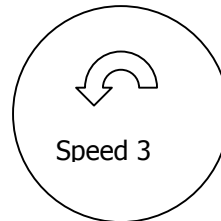
41. Secure a 6 $\mu$ m DLF to the platen.
42. Attach the fixture, activate platen rotation *clockwise* at 50 RPM and activate coolant.
43. Activate oscillation and lower the sample into the DLF until the dial indicator display reads 50 microns.
44. Polish the sample between 60-90 seconds. **Note:** Time will vary based on DLF condition/number of times used and sample size. Before proceeding to the next step, make sure the 15 $\mu$ m scratches have been removed.
45. Apply a Kempad polishing cloth onto a separate platen and place it on the machine.
46. Raise the arm five (5) full revolutions to compensate for thickness difference between the cloth and DLF.

47. Evenly apply 6µm diamond suspension onto the cloth. About seven (7) squirts on a new cloth should be sufficient (see "Notes" for information on polishing cloths).
48. Evenly apply RedLube™ onto the cloth. About four squirts on a new cloth should be sufficient. **Note:** RedLube™ is used to lubricate the cloth during polishing and when re-charging a cloth onto which diamond has been previously applied. When re-using the cloth, it is not necessary to apply as much diamond; instead, moisten it using RedLube™ and add approximately three to four squirts of diamond suspension as needed to maintain polishing consistency.
49. Attach the fixture and activate platen rotation *clockwise* at 200 RPM.
50. Activate sample rotation and oscillation.
51. Lower the sample using the spindle riser.
52. Using the vertical adjustment knob, lower the arm and sample into the cloth until the dial indicator displays between 40 and 60 microns. **Note:** The dial indicator will fluctuate due to unevenness of the cloth.
53. Set the timer for 4 minutes. Apply a squirt of RedLube™ every 30 seconds and diamond suspension every 60 seconds. A drip system consisting of a buret and stand may be used to semi-automate this process for unattended operation.

With **6µm diamond suspension and Kempad**



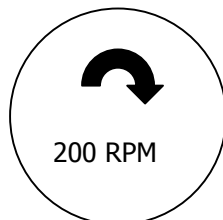
**Platen Direction**



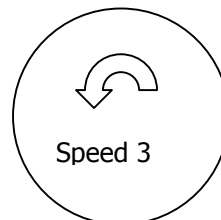
**Sample Rotation**

54. Remove the fixture and clean the sample for visual inspection. The scratches should appear light, without any chips, gouges or traces of 6µm DLF finish. If large scratches still exist, continue polishing in 60-second increments until removed.
55. Once the desired surface finish is achieved, swing the arm of the MultiPrep™ away from the platen and remove and store the polishing cloth/platen. Replace it with a Red Final C applied to a separate platen.
56. Repeat steps 47 – 53 using 1µm diamond suspension with Red Final C.
57. Remove the fixture and clean the sample. The scratches should appear light, without any traces of 6µm cloth finish. If large scratches still exist, continue polishing in 60-second increments until removed.

With **1µm diamond suspension and Red Final C**



**Platen Direction**

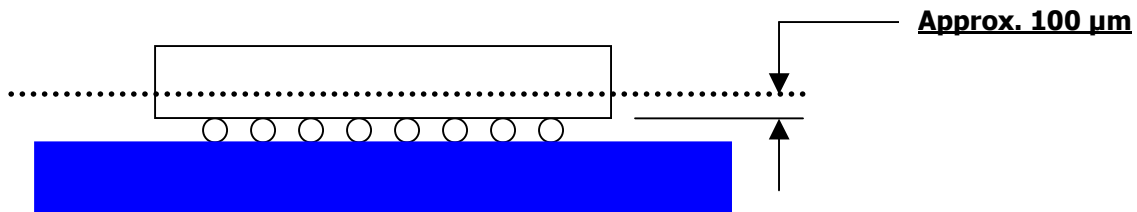


**Sample Rotation**

**Note:** If at this point it is necessary or desirable to produce a finer surface finish, Red Final C with 0.05 $\mu$ m colloidal silica may be used incorporating the following steps:

58. Raise the arm two full revolutions to compensate for thickness difference between the cloths.
59. Saturate the cloth with water.
60. Attach the fixture and activate platen rotation clockwise at 200 RPM.
61. Activate sample rotation and oscillation.
62. Position the water flow at the edge of the platen to wash the colloidal silica from the sides of the bowl.
63. Apply 0.05 $\mu$ m colloidal silica to the Red Final C cloth.
64. Lower the sample using the spindle riser.
65. Using the vertical adjustment knob, lower the arm and sample into the cloth until the dial indicator displays between 40 and 60 microns. **Note:** The dial indicator will fluctuate due to unevenness of the cloth.
66. Polish for between 1 and 2 minutes, and rinse the cloth and sample of colloidal silica for an additional 10 seconds. A drip system consisting of a buret and stand may be used to semi-automate this process for unattended operation.
67. Raise the sample using the spindle riser, remove the fixture and immediately rinse the sample with water for at least 5 seconds.
68. While rinsing, clean the sample using a cotton-tipped swab saturated with a diluted solution of Micro Organic Soap and water (1:10).
69. Using clean air (i.e. Aero-Duster), dry the sample in one direction **ONLY**. Failure to direct the air-flow in one direction will produce water spots on the polished section, contaminating the polished surface as a result.
70. Once the silicon is scratch free, place the fixture onto the hot plate to melt the wax and remove the sample.
71. If necessary, clean the wax from the sample by placing it in a beaker of Acetone. Isopropyl alcohol may also be used to remove residual Acetone before emission microscopy.

### **Final Thickness**





## **Notes**

### **Scratches**

In some cases scratches in the silicon are desirable. An example is for navigation in the IR or emission microscope, where scratches help locate a defect.

### **Cleaning**

Water can easily dry on the polished surface and resemble a scratch or "muddy" the surface with spots. It is important when drying the sample that the air travels in a single direction to avoid water spots.

### **Diamond Film**

A sequence of diamond lapping film may be substituted for the polishing cloths in this procedure. However, the speeds, times and other parameters will need to be altered.

### **Thinning to less than 50 microns**

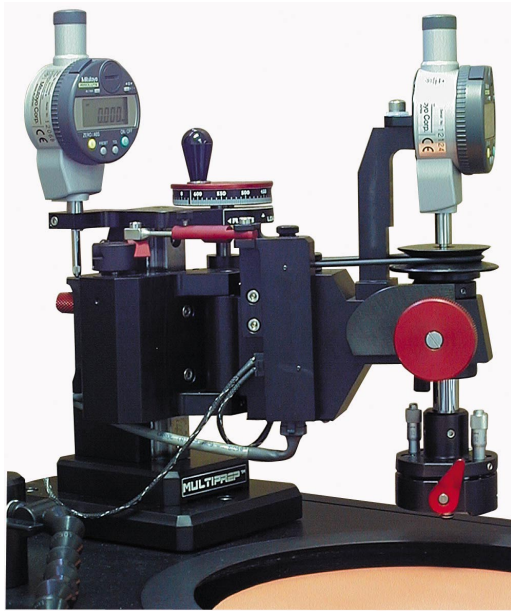
If thinning a sample to less than 50 microns, it will be necessary to incorporate additional steps after 15 $\mu$ m DLF that allow the sample to be polished at a faster rate than with the polishing cloths and diamond suspensions. Damage created from 15 $\mu$ m DLF may cause the device to crack apart as the sample is thinned to less than 75 microns. Therefore, the use of 6 $\mu$ m and 3 $\mu$ m DLF can be incorporated to thin the die to less than 50 microns. Removal rates can be measured using the measurement device and determined through experimentation.

### **Using Polishing Cloths**

If the sample is cleaned properly and scratches are not present, polishing cloths should last for many samples. Cloths should be kept on the platen and stored in a dust-free environment. Ziploc™ bags work well for platen storage. The micron size of the diamond and date adhered can be written on the outside of the bag for easy identification.

## 15-Indicator

This indicator displays the vertical movement of the arm and sample in 1-micron increments as the vertical adjustment knob is rotated. It improves resolution and makes it easier to control more precisely than using the vernier scale on the vertical adjustment knob (which is divided into 2-micron increments). Older MultiPrep™ units may require modification to the rear oscillator motor housing so the bracket may be attached. Modification to the MultiPrep™ is free-of-charge with purchase.



## Equipment Photo Page



**MultiPrep System™**

**Axioskop 2 MAT**



**Stemi DV-4**

