accuprobe

Probing the World of Microelectronics

PROBE TIPS #13

A Technical Bulletin for Probing Applications

The Importance of Probe to Probe Planarization

Probe test yield is the net increased result of fine tuning all the various aspects of the probe test function. Probe to probe planarization is one of the most important aspects of probe card assembly, inspection and maintenance.

It is not uncommon for users of fixed pattern probe cards to give little or no consideration to probe planarization. While everyone recognizes the importance of probe alignment and hitting the target, relatively little Attention is given to probe to probe planarization. Planarization directly or indirectly affects a number of other contact test variables such as contact pressure, contact resistance and scrub length and depth.

Overdrive is the additional Z motion after all probes have made initial contact with the device. Overdrive is applied to cause the probes to move on the surface of the test pad and thereby scrub through any surface oxidation to assure a low resistance contact. Overdrive also causes the probe to exert contact pressure on the test pad. The ideal combination of contact pressure and scrub is one where both are minimized yet still provide good contact. Poor planarization will result in uneven contact pressure and accelerated probe tip wear on the lower probes.

Planarization is critically important regardless of whether the device is a gallium arsenide high performance IC or a thick film Hybrid. Device size is irrelevant in determining the necessity of planarization accuracy.

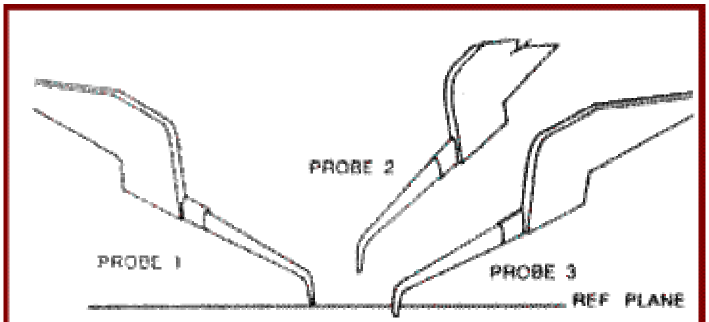

Figure 1

Figure 1 shows three probes; each of which having its probe point at different positions relative to each other. Only one probe (probe 1) is at the correct depth on the reference plane (planarization depth "D") while the other probes are either low or high.

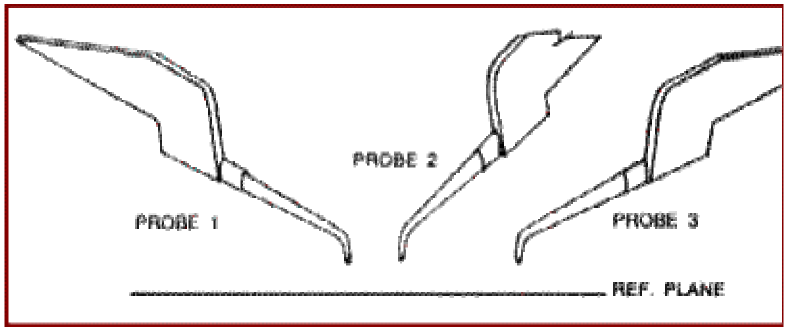

Figure 2 shows all three probe points to be on the same plane relative to each other but are not at the correct planarization depth.

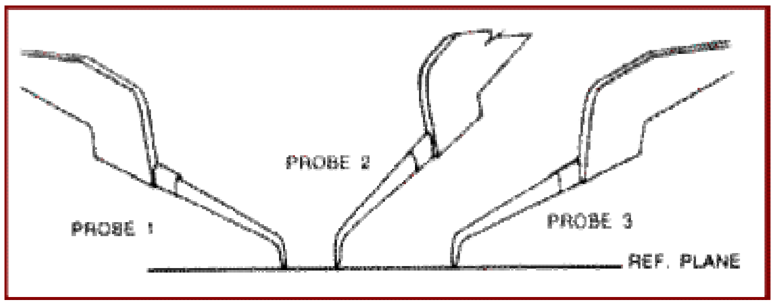

Figure 3 shows all three probes on the same reference plane and at the proper planarization depth.

In the preceding illustrations, Figure 1 would require excessive overdrive to allow probe 2 to contact the test pad. Uneven contact pressure could produce poor test results and probe 3 could damage the pad with excessive scrub or potentially punch through the pad and destroy the device.

Figure 2 is a common problem when probe to probe planarization is achieved without consideration for the specific planarization depth "0". While this situation is not as sever as the previous condition, it still has the potential for affecting the test results depending on hoe the prober senses contact and applies overdrive. This condition could become quite serious if the probes were all well below the reference plane and the prober or handler were set to stop Z motion at the reference plane. In this instance the probes could all be damaged due to excess probe deflection.

Figure 3 represents the ideal where the probes are at the same plane relative to each other and are at the specified planarization depth.

SMALLER NEEDS BETTER…

As geometries shrink, reducing bond pad size, contact area and scrub length are correspondingly reduced. The reduced target size places a limit on the amount of chuck Z motion or overdrive after contact occurs. The reduction in overdrive is actually desirable if it produces a smaller scrub mark because it permits easier bonding down the line. New delicate technologies such as Gallium Arsenide require uniform and lower contact pressure (measured in grams per mil of overdrive). Reduced overdrive automatically reduces contact pressure. However, reduced overdrive of 2 to3 mils from the norm of 4 to 5 mils for wafer probing also requires considerably better planarization of the probe card assembly.

As an example, assume that 2mils (50 microns) of probe deflection is required as a minimum for adequate scrub and low resistance contact. If 4mils (100 microns) of overdrive is normally applied, that leaves a 2 mil range for probe planarization. Therefore, a probe planarization tolerance of +/- 1 mil (25 microns) could be considered adequate assuming a typical planarization accuracy for epoxy ring or blade probes is.7mils (18 microns). However, when probing delicate Gallium Arsenide and other materials, or smaller geometries with reduced overdrive of 2 to 3 mils (50 to 75 microns), planarization accuracy becomes absolutely critical. Assuming 3 mils overdrive and reserving 2 mils for scrub and contact, only 1 mil remains for probe planarization range or +/- .5mil (12.5 microns). This calls for a much tighter tolerance than is typically achievable with epoxy ring and blade probes. A highly experienced and skilled technician may be able to achieve an accuracy level of +/- .35 mils (9 microns) with more time to planarize the card assembly. Z adjustable probes are typically adjustable to within +/- .2 mils (5 microns).

HYBRIDS TOO!

The same holds true for larger hybrid devices. Normal overdrive in a typical laser trim operation is 15 to 20 mils or more. An effort should be made to reduce overdrive to 10 to 15 mils maximum. This is particularly important for thin film hybrids with typically smaller geometries. Laser trimmers lack the fine overdrive adjustment capability as found on wafer probers. However, with patience and careful adjustment considerable accuracy can be achieved.

A high level of planarization accuracy is also important when probing larger geometries. Although larger geometries provide plenty of room for scrub, there is mistaken belief that planarization is less important. Poor planarization invariably results in excess overdrive. Excess overdrive produces a longer scrub mark which results in excess probe wear and shorter probe life. The probe needles may also be over-stressed and damaged.

Since contact force increases as a function of additional overdrive, the device could be damaged with underlying micro-cracks below the test pad due to excess contact pressure. Again, the objective is to minimize overdrive to the extent that a reliable contact occurs between the test probe and the test pad.

In a typical Hybrid test or laser trim application with a 25 mil thick 4x4 inch substrate or snapstrate, a flatness specification of +/- 1 mil per inch is typical. The above substrate could therefore have a total range of 8 mils across the surface. Assuming that 2 mils are required for contact and scrub, a minimum of 10 mils is required to probe the substrate if the planarization is perfect. Here is where planarization accuracy for Hybrid circuits becomes important. The planarization range of the card assembly must be added to the above 10 mils to determine a practical overdrive specification for the above sample application. If the planarization range is held to +/- .5 mils the total overdrive required for the sample application could be 11 mils.

Again, a common mistake is to assume that thick film Hybrids do not require accurate planarization. In order to reduce overdrive and all the resulting effects of contact pressure and excess scrub it is necessary to accurately control probe to probe planarization. In high volume application such as trimming resistor chip arrays, a typical concern is how long will the probe last. Accurate planarization with minimal overdrive will provide maximum life and performance from the probe card assembly.

INSTRUMENTATION

These levels of probe planarization accuracy require precision instrumentation to achieve dependable and repeatable results. There is absolutely no way that one can rely on eyeball measurements to achieve acceptable results. Quality equipment should provide a repeatable measurement accuracy to within 5 microns.

See Accuprobe's literature for the Model PTS-100 Planarization Station and the PDL-100 planarization Display.