accuprobe

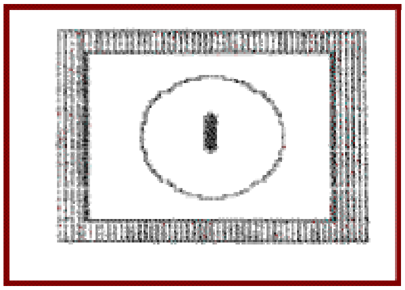
Probing the World of Microelectronics

PROBE TIPS #11

A Technical Bulletin For Probing Applications

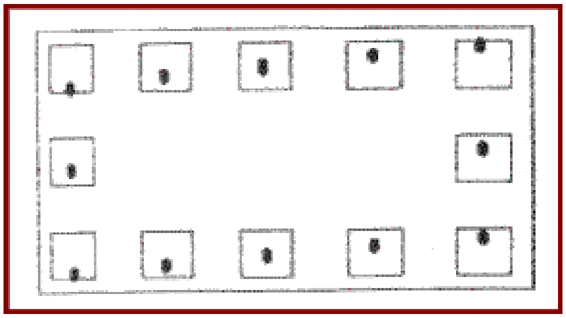
Probe Mark Analysis

Probe marks are the "foot Prints" left behind by the probe tips after contact with the test pad. Probe marks become the evidence to provide clues to a wide variety of probing difficulties. Careful visual analysis of the marks can assure quality control or point to potential trouble in need of corrective action.



X- Y Alignment

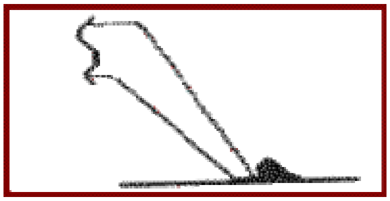
X- Y alignment is perhaps one of the most common problems. It is the most visibly obvious problem and is very simple to correct. Probe placement should always aim to hit the approximate center of the test pad after applying overtravel. When examining a device which has been probed, it is easy to spot probe misalignment since the resulting scrub mark will be visibly off center on the test pad. A common technique used by some manufacturers is to design into the test pad a circular target, which represents the tolerance range within which the mark must hit. Such a technique forces the establishment of a target specification and speeds up the visible QC process. If alignment is found to be visibly off center due to the amount of overdrive and the size of the pad, the target specification was not met. If such misalignment is found, the probe could be scrubbing into the glassivation and quickly contaminating the probe tip, contributing to decreased probe tip life. Worst case scenario, the glassivation is broken and the part is scrapped. Alignment problems could indicate a faulty setup procedure or a careless/ inexperienced operator. The most common alignment setup error is theta adjustment (rotational error). This is indicated when the probe marks on one side of the die are toward the outside edge of the pad and the other side of the die has the probe marks toward the inside of the die.



Extra care taken to align the probes will contribute to reduce setup costs, longer probe life and higher yield through faster setup and improved contact.

PROBE PLANARIZATION

Probe to probe planarization, which is the relative probe to probe height in relation to the test plane, is a little more difficult to detect but can be seen through a coaxial microscope which provides some depth perception. Low probes, which contact the device first, will exert relatively more contact pressure and penetrate the pad surface deeper than higher probes. Additionally, the probe scrub length will be longer due to an approximate 10:1 ratio of overdrive to forward scrub motion of the probe tip. A deeper probe tip will also tend to wear faster, due to the longer scrub, and may leave "snowplow" scrub mark.



This snowplow scrub results from the probe tip penetration into the pad material. When the tip moves forward with overdrive, the tip penetrates further and pushes pad material forward leaving a mound of pad material at the forward end of the scrub mark. Conversely, a high probe will have a shorter scrub mark and will be shallower due to the lighter contact pressure. The combination of random deep, wide, long marks with shallow, thin short marks clearly indicates a planarization problem. Probe planarization is among the most important aspects of fixed pattern probing where even perfection is never good enough.

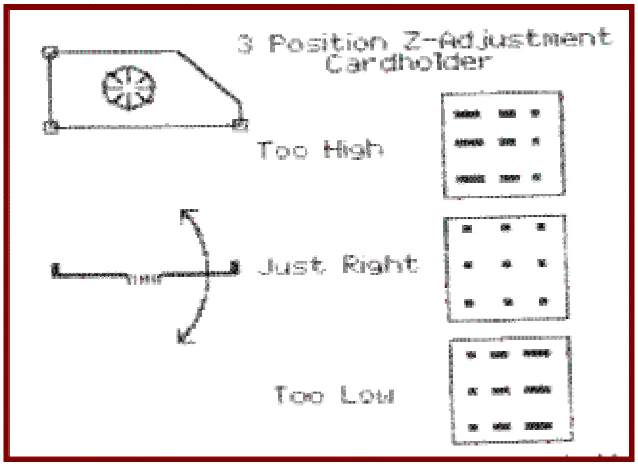
WORN OUT PROBES

Worn probes will generally show up as wider scrub marks and will often produce a snowplow scrub mark. The snowplow effect in this case is due to the tip shape being worn flat over time. The flat shape tends to act like a chisel to dig under the pad material, lift it up and push the material forward as the probe moves forward with drive. Uneven wear on probe tips indicates planarization problems. Uniform but excessive wear on the probe tips indicates that the probe card assembly has reached the end of its useful life.

SYSTEM PLANARITY

The cardholder in the prober should be calibrated to be flat and parallel to the top surface of the chuck. This will insure the simultaneous contact of all the probe tips. If the cardholder or chuck is out of plane in relation to the other, probes on one side of the die will touch down before the other side of the die. The lower probes will scrub more than the higher probes and the problem can be easily identified with visual QC. Probers that are designed with three position z-adjustment cardholders (such as Electroglass 1034) should be checked and calibrated regularly. These probers have only one z adjustment position where the table is flat and parallel to the device chuck and lead screw axis. In the example illustrated below only one position of the table provides uniform probe marks.

When the table is not adjusted properly, some of the probes are lower on one side of the device and higher on the other. The lower probes contact before the high probes and produce a longer scrub mark. Similar results occur if the device chuck is not parallel to the cardholder and lead screw axis.



Good system planarity implies that the prober (or device handler for laser trim systems) is checked regularly as part of a routine preventative maintenance program. This will insure that the cardholder and device chuck are flat and parallel to an established reference plane (usually the lead screw axis or air0bearing surface of the prober).

OVERDRIVE

The additional Z motion of the device chuck (or cardholder in the case of some laser trim systems) after initial probe contact is referred to as overdrive. The purpose of overdrive is to insure acceptable contact resistance by causing the probe tips to scrub forward and break through ant oxide on the surface of the test pad. Excessive or insufficient overdrive will result in deep wide long or shallow, narrow, short probe marks. Assuming that the probe card is properly planarized, marks produced with excessive or insufficient overdrive will be consistent throughout the wafer (inconsistent marks would indicate probe planarization problems as discussed earlier.

When probe test pads are constantly being damaged or probe tips are frequently damaged or broken with little apparent explanation, a rare but curable problem may exist. The condition is caused as a result of a faulty or out of calibration motor controller which is causing the Z stage to approach the test probes at excessive speed. Typically, chuck motion consists of acceleration to a predetermined speed, followed by deceleration. When the chuck approaches its target location, it begins to slow at a predetermined rate. T6his ramping up and ramping down in mechanical motion is intended to produce a precise and successful landing of the probe tips to the device pads. If a controller malfunction occurs, the prober could cause the device to impact the probe tips at excessive speed. The probes may then deeply penetrate the test pad rather than scrub and potentially damage the circuit or probe tips. The chuck ramping calibration is usually easy to check and adjust on most probers.

CONCLUSION

Probe tip shape influences the quality of the contact and the shape and size of the scrub mark. The placement and the general qualities of the scrub marks provide a feedback opportunity to the test engineer to identify and correct many problems, which have a dramatic impact on test yield. Careful analysis of probe scrub marks will allow the test engineer to follow the trail of clues to improved test performance.