Probing the World of Microelectronics

PROBE TIPS #8

A Technical Bulletin for Probing Applications

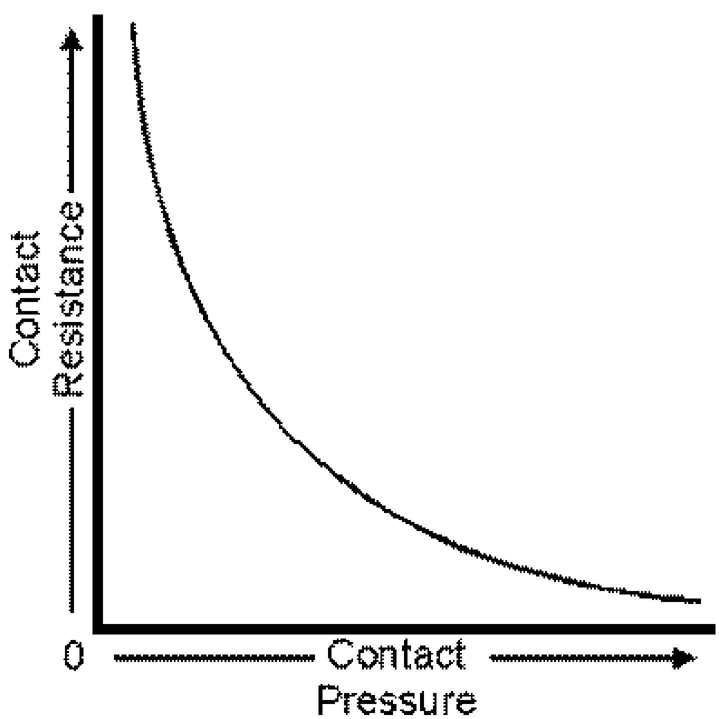
Probe Contact Resistance

Probe contact resistance has become increasingly important as signal voltages drop, contact pressures decrease and new device technologies like gallium arsenide draw higher currents. Signal integrity has become even more dependent on probe contact quality.

Probe contact resistance varies as a function of a number of independent variables.

CONTACT PRESSURE

Probe contact pressure is defined as the force, (measured in grams) which is exerted by the probe tip (measured in mils or microns) on the contact area. Tip force is primarily controlled by prober overdrive, increasing linearly with additional Z motion. Additionally, needle material, needle diameter, beam length and taper length also play a major role in determining tip force. The contact pressure relationship to contact resistance is illustrated in Figure 1. Essentially, as the probe makes initial contact and begins to penetrate the surface layer of bond pad contamination and oxide, current flow quickly begins and increases as more sub-surface bond pad metal is contacted. The contact resistance will continue to decrease as pressure increases and then level off to the normal contact resistance of the two metals.

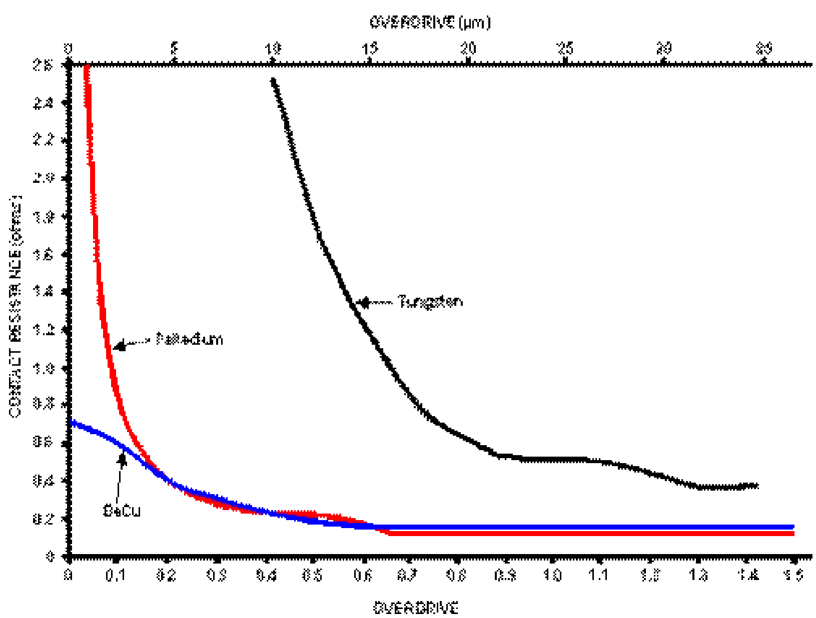


PROBE MATERIAL

Probe needle material contributes to contact force because the modules of elasticity (stiffness) differ among materials. The probes bend and flex differently given equal overdrive and exert different amounts of force on the test pad. As probes are exercised over time, fatigue affects stiffness and results in changes in planarization. Tungsten is most resistant to fatigue, Beryllium Copper (BeCu) is good but Palladium is poor and thus difficult to keep planarized

The different probe materials have different intrinsic contact resistance characteristics depending on the bond pad material to be contacted. The chart below will provide a clear view of the material specifications and their resultant optimal contact resistance.

Specifications and features	Beryllium Copper	Tungsten 99.99% pure	Palladium
Resistivity at 20°C µΩ cm	7.68	5.50	3.16
Modulus of Elasticity (lb/In^2)	19 x 10^6	59 x 10^6	16.8 x 10^6
Maximum Rockwell Hardness (c)	3.0	7.0	4.8
Fatigue resistance	Good	Excellent	Very poor
Contact resistance	100 µΩ/gold 200 µΩ/ alum excellent/stable repeatable due to selfcleaning action	250 µΩ/gold 250 µΩ/alum fair/unstable unrepeatable due to build up of contaminates	100 µΩ/gold 200 µΩ/alum excellent/unstable due to lack of planarity over use



Accuprobe does not offer a Palladium alloy tip because of the difficulty maintaining planarity with this material. There is clearly a relationship of contact resistance to overdrive as discussed earlier, which can be influenced greatly by the needle material selection. Figure 2 shows the relative contact resistance vs. overdrive of the three materials.

BOND PAD CONTAMINATION

Typically, a bond pad can be coated with a film of oxide and other environmental contamination (dirt) which can significantly affect contact quality. Aluminum bond pads form an oxide coating instantaneously on exposure to air. Gold bond pads can also develop a measurable contact resistance due to absorption of airborne contaminants on the surface rather than chemical reactions with the gold. The pressure of the probe tip bearing down on the pad surface and then the scrubbing action of the probe tips will typically bring the contact resistance down to normal values.

PROBE TIP CONTAMINATION

Probe tips can contribute to high contact resistance due to surface contamination and in the case of Tungsten, debris is impacted within the compressed strands of the Tungsten material.

High temperature probing can dramatically increase the level of oxide buildup on the surface of the probe tips. As such only BeCu tips should be used for high temperature testing since the self-cleaning action will keep contact resistance to tolerable levels.

Temperature probing in a dry nitrogen atmosphere will reduce oxide buildup and contribute to low contact resistance.

PROBE TIP CLEANING

The softer and solid BeCu and Palladium probe materials are typically self-cleaning due to abrasion while probing. However, surface contamination can usually be removed with a two or three-minute soak in Freon, TCE or similar solvent followed quickly with a gentle wipe with a soft brush. Conventional aerosol contact cleaner can be used for spot cleanups. An ultrasonic bath is frequently used for routine probe card cleaning.

Abrasive cleaning is a common practice where probe tips are exercised by deflecting the probe tip on a clean piece of ceramic. While this practice is in common use we have seen where this practice has not only temporarily reduced contact resistance and in fact impacted additional non conductive debris into the crevices between strands of Tungsten which forms the tip. A better cleaning material for the purpose is .5 micron chromium oxide abrasive film available from a number of suppliers including Resistox offered by Accuprobe. Resistox is simply placed on the prober chuck and the probes are exercised approximately 10 times with 4 mils overdrive. After abrasively cleaning the probe tips, they should be washed in a cleaning solvent.

After any cleaning operation and prior to use of the probe card assembly, the probes should be checked for alignment on the device followed by a probe tip planarization check.

The probe card assembly should again be ready for service with nominal contact resistance due to probe tip contamination.