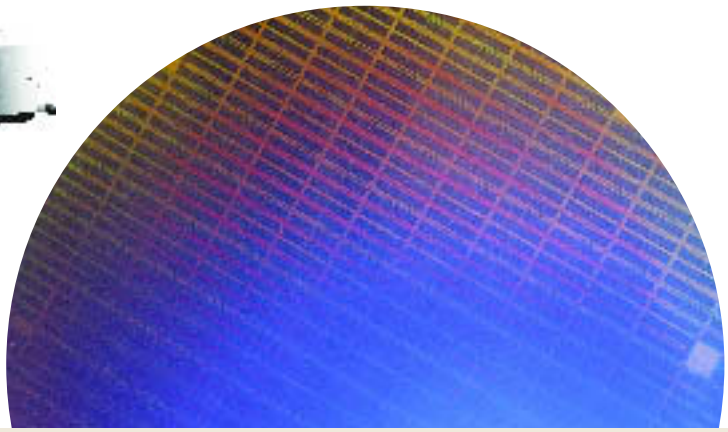
Copper Analysis Library Option



Struggling to turn copper into gold?

Today's new copper processes are often paired with low-κ dielectrics. While these new materials offer advantages like lower resistivity, increased resistance to electromigration, decreased capacitance, reduced power consumption, and higher device density, they also present significant new technical challenges in process monitoring. For example, copper diffuses readily into some dielectrics. To prevent this diffusion, a layer of barrier metal is applied between the copper and the dielectric. Fabs must be able to monitor the thickness of the diffusion barrier layer after Chemical Mechanical Polishing (CMP), as well as the dielectric constant of the low-κ inter-level dielectric. They also need tools that allow them to monitor the degree of "dishing" due to CMP.

Like to browse through Keithley's library?

To help fabs address these challenges, Keithley has bundled a library of copper process analysis algorithms and test structures with other utilities that can speed and simplify copper process monitoring. The Copper Analysis Library is a layered software option designed for use with Keithley S600 Series testers running KTE V4.2.2 or later. The Option's documentation includes recommendations for copper test structure designs (patent pending).

Nine new copper test algorithms (patent pending) can be easily incorporated into parametric test sequences. Algorithms are provided for:

- Measuring the breakdown voltage of a metal line sidewall oxide
- Copper line width measurement
- Calculating the resistance of a four-terminal metal line
- Four-terminal Van der Pauw measurement for metal sheet resistivity
- Corrosion induced metal leakage current measurement
- Sidewall leakage measurements
- Vertical resistance measurement for copper lines deposited with the dual damascene process
- Metal line sidewall capacitance extraction
- Testing the mechanical strength of a sidewall oxide exposed to thermal expansion stress from a Joule heated metal line
- Low-κ dielectric absorption

Need to clean up your results?

Copper presents special probing challenges. For example, copper oxide particles tend to adhere to probe needle tips. This contamination can lead to a loss of continuity and affect measurement accuracy. The Probe Tip Cleaning Option simplifies programming the tester to initiate a cleaning cycle after every user-defined number of touchdowns. Also, probing copper pads typically doesn't produce the scrub marks that are used to verify contact with aluminum pads. Keithley's SofTouch probe height adjustment solution minimizes overdrive while ensuring good electrical contact.

PROBE TIP CLEANING OPTION

Keithley Copper Analysis Library–The Solution to Your Dual Damascene Process Verification Challenges

Challenge:

"I'm having problems determining the thickness variation in my barrier metal/Cu lines using laser-induced ultrasound techniques. Is there a better way to do this?"

Solution:

Several factors can affect metal line thickness, including overpolishing at CMP, proximity effects in certain geometries, or the deposition of an unusually thick barrier layer. The Copper Analysis Library provides a technique for determining the thickness variation of a copper line electrically.

Challenge:

"We're using a low-κ dielectric and we're suffering yield losses due to sidewall oxide defects. How can Keithley's Copper Analysis Library help?"

Solution:

While low-κ dielectrics provide lower capacitance than the traditional higher-κ dielectrics, they are more susceptible to cracking. Therefore, it's critical to know the mechanical strength of a sidewall oxide. Keithley's Copper Analysis Library includes a test that determines the strength of a sidewall oxide that undergoes thermal expansion due to Joule heating of a metal line. The library also provides tests that can be used to determine the presence of other defects, such as the diffusion of copper ions into the dielectric, which are not detected with visual inspection techniques such as SEM.

Challenge:

"I'm getting unacceptable current leakage between two metal lines. How can I determine if it's due to interline corrosion?"

Solution:

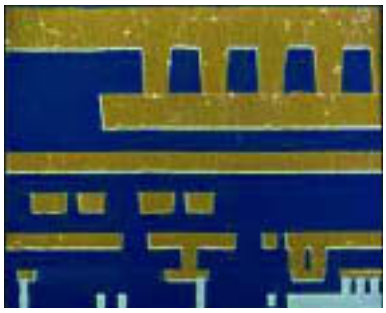
When a semiconductor device is exposed to light, the photoelectric effect will cause electrons to flow from the n areas to the p areas of the semiconductor. If an electrolytic solution (e.g., the wash solution used after Chemical Mechanical Polishing) is present, this electron flow will cause corrosion to occur in the Cu line associated with the p area. One of the corrosion products will form conductive dendrites on the surface of the wafer between the Cu lines associated with n- and p-type areas. This may cause current leakage between the lines. High resistance in the p area Cu line can also occur as a result of corrosion. The Keithley Copper Analysis Library provides a test structure and algorithm for detecting leakage due to this corrosion.

Challenge:

"When the tester alerts me that I have bad readings, how can I tell that it's an actual process failure, not just the result of a loss of continuity due to poor electrical contact or contaminated probe tips?"

Solution:

At the beginning of a lot, after wafer alignment, the tester automatically performs a SofTouch procedure to establish good electrical probe-to-pad contact. If this procedure fails, the system may be configured to have the tester automatically call up the Probe Tip Cleaning Option, after which the SofTouch procedure is repeated. If the second contact attempt is successful, the tester automatically begins the test sequence. When this technique is used, the operator can be confident that any bad measurements obtained are due to process issues.*



Copper interconnections.
(Photo courtesy of IBM)

For more information on how Keithley's Copper Analysis Library Option can help you control your copper processes more effectively, contact your Keithley sales representative.

*Applicable only to prober models that support SofTouch.

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