Reduce Thermal Soak Time during Over-temperature Device Characterization With the eVue Digital Imaging System

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Overview

With smaller pad sizes becoming more common, there is an increased need for probe positioning accuracy during wafer test to ensure accurate test data. In order to increase accuracy for small pad probing, accurate Z height control becomes critical to avoiding errors caused by wafer height variations for ambient and over-temperature on-wafer testing. This paper presents Cascade Microtech's solution to this issue using wafer profiling and dynamic Z-height control during thermal probing.

Shrinking Design Rules

One of the most influential market drivers in the area of wafer probing technologies is the trend of shrinking geometries as designers attempt to fit more ICs onto wafers. One way they have done this is to reduce the size of test pads. With smaller pad sizes becoming more common there is an increased need for probe positioning accuracy during wafer test to ensure accurate test data.

There are multiple issues that affect positioning probes on wafer test pads. In the past, X-Y stepping accuracy was the biggest hurdle to overcome, however newer cost-effective mechanical control systems now allow X-Y positioning accuracy down to the sub-micron level, even for 300 mm wafers. The remaining challenge is achieving tightly controlled Z contact height because of a reduction of allowable overdrive on probe tip touchdown.

Managing Z Contact Height

During probing, the probe angle causes the tip to skate horizontally on the pad, which can significantly impact the accuracy of test data if the overdrive is not carefully controlled. In order to increase accuracy for small pad probing, accurate Z height control becomes critical to avoiding errors caused by wafer height variations. Profiling wafers prior to measurement can dramatically improve the measurement repeatability through better contact resistance and more accurate RF calibrations. Z-Profiling also avoids damage to the bond pads and the IC passivation layer, and extends the life of probe cards and RF probes.

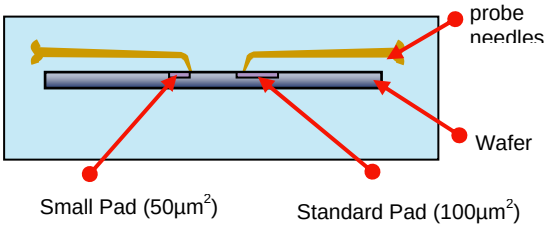

Figure 1: With standard overdrive, the probe needle will skate off small test pads.

Over-temperature Measurement Challenges

In order to test at multiple temperatures with wider ranges, a wafer must be placed on a thermal chuck inside the probe station. The thermal system will first transition to a set temperature, and then a test may begin. However, after the thermal chuck has reached the required test temperature, its height and flatness continues to change until it has mechanically stabilized. This transition, defined as soak time, can take up to two hours to occur for wide temperature ranges.

Even if a Z-profile map is enabled for the specific temperature, it is not usable until the soak process is complete. If operators ignore thermal soaking, the test must be stopped, contact height reset, and the test restarted in order to ensure accurate probe touchdown on the wafer. This may need to be repeated often, until stabilization has occurred. Although probes can tolerate small wafer height variations, if the contact height is not reset throughout the test, the probe tips may skate off test pads.

This is a critical challenge when probing at temperatures other than ambient temperatures; if contact-sensitive devices are probed with non-uniform probe overdrive there is a risk of collecting erroneous test data. This requires an efficient method for monitoring and compensating for wafer changes due to thermal

effects. However, the two current compensation methods make characterization in thermal environments extremely time-consuming. Users are either required to wait up to two hours for thermal soaking or they must stop and restart the test after manually resetting contact height.

Measurement Challenges Solved

Cascade Microtech's eVue digital imaging system provides a solution to the issues of fluctuations of wafer flatness in thermal characterization. With the eVue digital imaging system, users can easily measure and apply a complete map of wafer height (Z-profile map). eVue can also automatically adjust the Z height in real time to allow probing during the critical soak-time, as chuck and wafer height change, eliminating unnecessary wait time in the process.

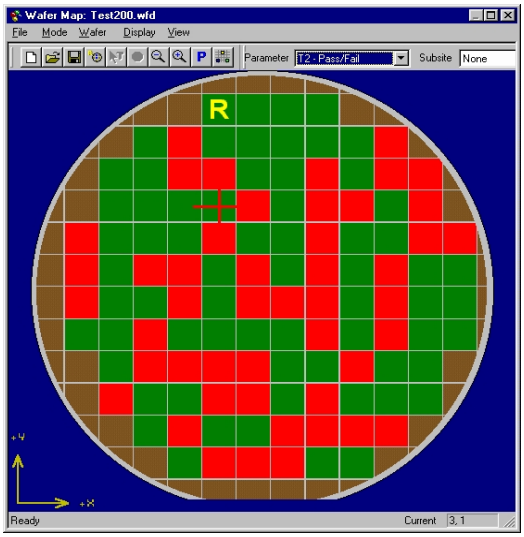

Figure 2: eVue can optimize Z-height for all wafer die locations

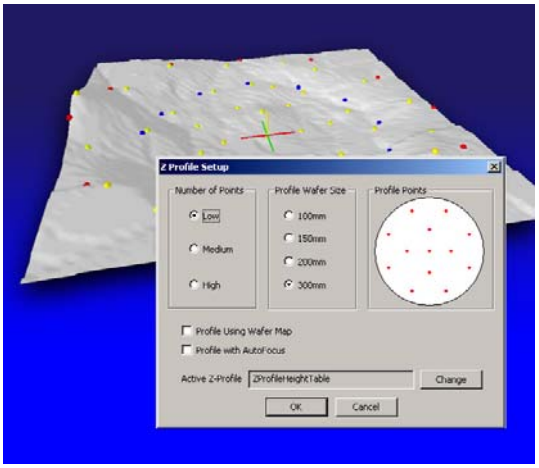

Figure 3: Z-Profile Map using eVue

eVue digital imaging system

Cascade Microtech's eVue digital imaging system is optimized for on-wafer test with Cascade Microtech probe stations. eVue offers enhanced viewing, superior wafer navigation, and accurate wafer profiling for test data collection. The eVue digital imaging system allows users to accomplish more in less time. It combines new wafer and probe navigation tools with next generation digital microscope technology and advanced video processing technologies, enabling dramatic productivity increases in on-wafer test.

Figure 4: eVue Digital Imaging System

Sub-micron focus stage

eVue incorporates a precision sub-micron focus (Z) stage, and a digital remote control for "hands-off" microscope image focusing. When manually focusing at high magnification levels, eVue allows engineers to precisely focus the live video image without disturbing the microscope. The focus stage is utilized for Auto-focus and Z-profiling with eVue Pro Package systems.

Powerful software toolkit

The Pro Package version of eVue includes a comprehensive software toolkit that adds powerful automation and productivity capabilities. The toolkit has three software operation modes; Multi-View, Multi-Z, and Multi-Cam.

Multi-View mode enables fast probe-card alignment and multiple test device viewing by utilizing the capability to see multiple digital views, each at different wafer locations and magnifications.

Multi-Z mode provides microscope auto-focus, optical height sensing and wafer profiling. Engineers can easily create wafer profile maps for multiple test temperatures, and recall them at each temperature to ensure precise probe touchdown and accurate data collection. Wafer Z height can also be measured in real-time during "thermal soak time", thus eliminating wasted time.

Multi-Cam mode (Figure 5) offers one, two, or three simultaneous live video views, each at a different perspective of the same device under test, so probe navigation and tracking is easier. Viewing can be optimized with picture-in-picture or side-by-side display layouts.

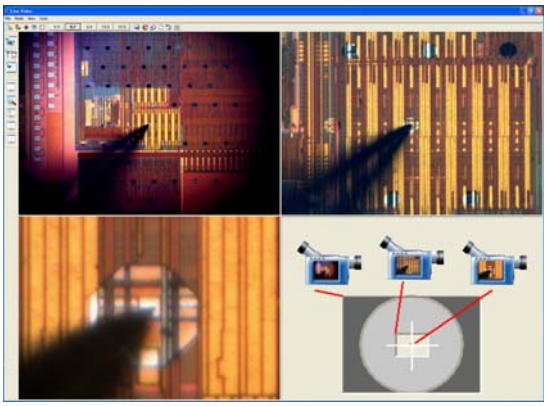

Figure 5: Multi-Cam mode viewing

Paradigm Shift in Test Methodology

Traditional approaches to the challenges in wafer probing in recent years have resulted in incremental improvements in microscope design and automation. However these approaches still do not address wafer contact issues that lead to inaccurate test data collection.

Accurate probe contact requires the ability to measure and compensate for contact height fluctuations on wafers. Until now, traditional approaches to solving test problems have not utilized the power of digital microscopy. Cascade Microtech's eVue digital imaging system is a revolutionary solution that radically improves wafer navigation, test setup and probe contact accuracy through the integration of microscopy, digital imaging, and software automation. eVue offers enhanced high-definition video, superior navigation and excellent accuracy for viewing and profiling a device under test. The eVue digital imaging system allows users to navigate, observe, and measure devices well beyond what is currently possible.

For engineers and scientists who need to make precision measurements, Cascade Microtech's probe stations with eVue digital imaging systems deliver access to, and extraction of, accurate electrical data from small structures on wafers, integrated circuits (ICs), IC packages, circuit boards and modules, MEMS, biological structures, and electro-optic devices.