Push-Pull Capacitance Sensor Measures Ungrounded Targets

Today's semiconductor and solar industries drive the demand for thinner wafers to conserve silicon and fulfill new IC applications. To meet this demand, wafer fabricators seek greater dimensional control of their silicon products.

Non-contacting capacitance sensors offer the precision, accuracy, and speed needed to measure flatness, thickness variation, and other critical dimensions. Typically, the sensor acts as one plate of a classical two plate capacitive gap measurement scenario. The grounded target – i.e. the silicon wafer – forms the second plate.

Grounding, however, presents challenges. First, it can scratch or damage the wafer which is fragile and expensive. Second, it prohibits those sensing scenarios where the wafer must be moved to acquire all metrology measurements.

While there are ways to overcome the grounding challenge – parasitic capacitance coupling, a second sensor working 180 degrees out of phase, or a grounded chuck to support the wafer – they offer limited effectiveness. This application note describes a better solution: a push-pull probe specifically designed for ungrounded targets.

Problem

Measure the thickness and warp of 156 mm^2 photovoltaic (PV) wafers as they pass at the rate of one wafer per second? The required accuracy is < 1um.

Solution

In the scenario described above, it is virtually impossible to ground the wafers as they pass by the capacitance probes. Even if it were possible, poor grounding would introduce unacceptable noise to spoil the results.

MTI's proprietary push-pull probe systems measure ungrounded semiconductor wafers. Based on conventional capacitance measurement principles, the design features two capacitance sensors built into one probe body. Each sensor is driven at the same AC voltage with a 180 degree phase shift between signals. The shift allows the current to travel across the target surface rather than through the target to ground, eliminating inaccuracies created by poorly grounded targets.

MTI's AS-562-PP amplifier sums up the individual output signals, producing a single 0 to 10 VDC output that is proportional to the probe-to-wafer gap. Sub micron accuracy is achieved at probe standoff distances up to two mm.

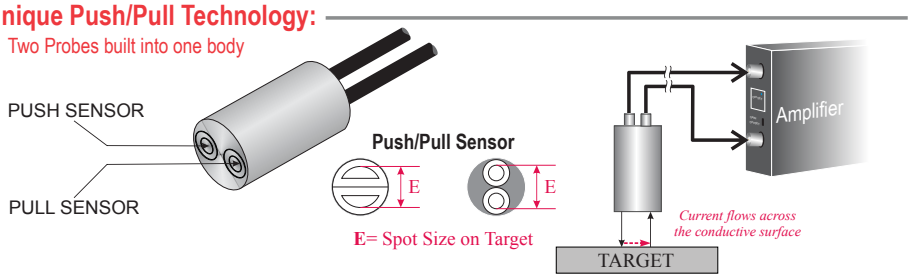
Benefits

- Push-pull probes are passive and extremely stable over a wide temperature range
- Push-pull technology can be used on highly resistive targets
- There is no need to recalibrate the probes for changes in target material
- The push-pull amplifier design cancels common mode electrical noise that may be induced in the target
- Thickness measurements are taken using every portion of the voltage output range with no decrease in device accuracy

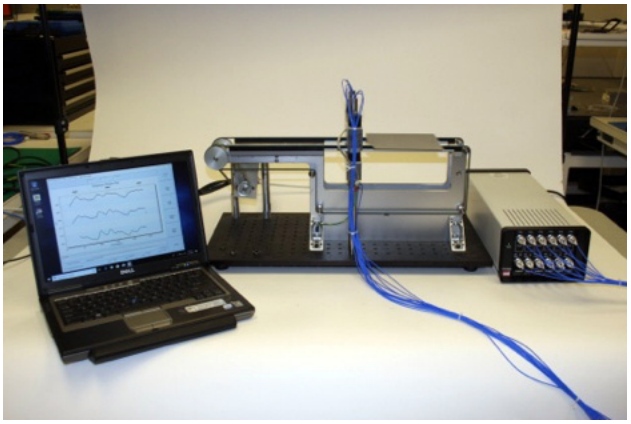
Semiconductor wafers such as those used to make integrated circuits (ICs) and silicon photovoltaic (PV) cells are fragile and expensive. The ability to precisely measure critical wafer parameters such as bow and warp not only ensures the integrity of circuit patterns, it improves yields and lowers production costs.

Unique Push/Pull Technology:

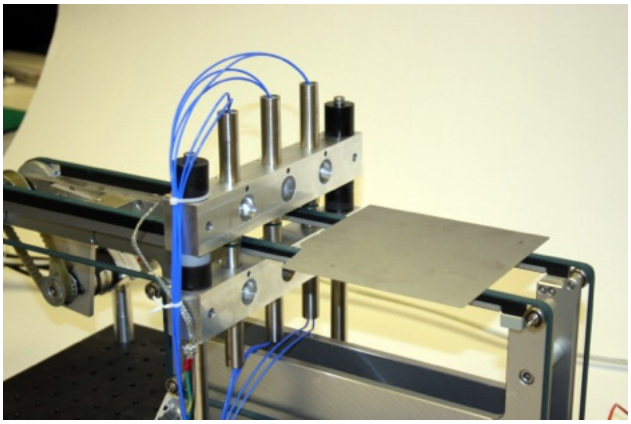
Two Probes built into one body



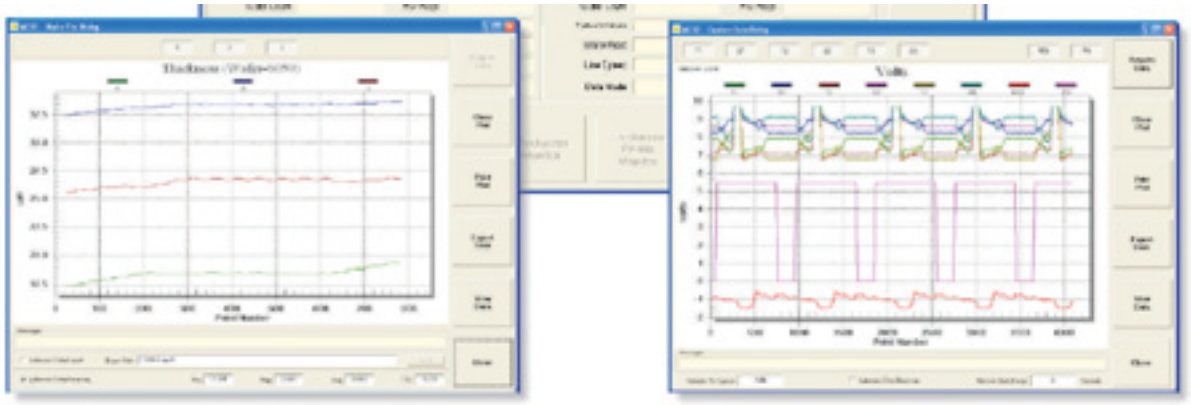
The Push-Pull probe is a unique version of MTI's Accumeasure™ amplifier series. This special design provides accurate surface information for wafer bow and warp.



MTI sells integrated measurement systems exclusively designed for the PV market. The Proforma PV-1000 (shown here) meets ASTM measurement specifications.



Three sets of push pull probes profile the PV wafer.



With a PLC and special software, the PV-1000 system measures, logs, and assists in binning wafers.

MTI's Proforma 300SA uses push-pull technology for wafer mapping.

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