Abstract

Warpage is a major issue in the mass production of silicon wafers. Metal materials (often copper) are deposited on the wafer for routing as well as relative thick layers used as a heat sink for cooling. There is a significant difference in the thermal coefficient of expansion between copper and silicon. The cooling of the wafer from the processing temperature to room temperature may warp the wafer.

Wafer warpage creates problems on the production line because the vacuum cup that holds a wafer during transport cannot create a seal on the wafer's backside. The vacuum cup is capable of accommodating small amounts of warpage, however not all wafers have a warpage within the cup’s tolerance.

Currently, a technician measures the warpage using a ruler, however this is not a suitable method for long term use. Texas Instruments, a major producer of silicon wafers, has asked Silifer to create a prototype that is capable of accurately measuring the amount of warpage on any given wafer.

Final Design

The prototype measures warpage similar to a height gauge. The wafer is loaded onto the base in between the brackets with the lowest edges of the wafer against the brackets. This will place the edges with the maximum warpage in line with the laser. The laser is then raised from the surface of the base, via a micrometer adjusted stage lifter, until the beam is visible on the wall. The micrometer has a digital readout that displays the maximum height of the warpage.

Conclusion

Three test subjects made three measurements each for two test blocks and the averages are shown in the table below. The ¼ inch block measured to 0.2525 inch and the ½ inch block measured to 0.5030 inch. The blocks were first measured with the bare laser and again by the same laser with a cap over the beam outlet to decrease the laser diameter.

The results show that the laser with the cap is more accurate than the bare laser, however both are within our allowed error tolerance.

Looking Forward

For optimization of this design, Texas Instruments could use a laser with a smaller diameter beam to decrease user error. This would also eliminate the necessity of the cap that we used during our testing. Texas Instruments may also find that a higher degree of automation will aid in the wafer production process. The design may be modified to accommodate a robotic arm placing or holding a wafer in the system.

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