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Reports from the Fab

Fab Establishes Co-Planarity Across Vertical Diffusion Process to Reduce Wafer Particle Contamination, Improve Yield

The User

A 300 mm fab for one of the world's largest chipmakers.

Multi-Wafer Diffusion Process Calls for Co-Planarity Among Stations

Wafers being processed at a 300 mm fab's vertical diffusion furnace received micro scratches during uneven handling and z-axis movement that led to particle contamination, scrap and shattered wafers. The lack of co-planarity among the tools and wafers throughout the multi-wafer process reduced yield and led to prolonged equipment and staff downtime to troubleshoot contamination sources.

Wafers in the process traveled, 25 at a time, in a front open unified pod (FOUP) to the robot end effector, which fed five full FOUPs, or 125 wafers, into the wafer boat that transferred them up into the furnace, operating at approximately 1,200˚ C.

The number of wafers being handled and narrow pitch between wafers in FOUPs and the wafer boat made wafers traveling through the process susceptible to damaging micro scratches if a station in the process wasn't level.

"Every station in the process and wafer position really has to be in line and consistent when you're processing that many wafers in a tight space," said Allyn Jackson, customer supporter manager at CyberOptics Semiconductor.

The long vertical path wafers traveled in the wafer boat, which often became crooked, also made them vulnerable to micro scratches and further damage in the hot furnace, Jackson said.

Engineers ran a batch of test wafers after using tools such as bubble levels and calipers and line-of-sight checks to attempt to establish co-planarity among the FOUPs, robot and wafer boat.

Jackson added that engineers didn't examine the alignment of the wafer boat along the z-axis path as it approached and entered the furnace. Engineers stopped the process for calibration troubleshooting only after finding severe particle contamination and wafer damage coming out of the furnace.

“The legacy leveling method that engineers employed wasn’t accurate and really forced them to react to defects after they occurred,” Jackson said.

Establishing Co-Planarity Throughout the Diffusion Process

Engineers operating the vertical diffusion furnace loaded a 300 mm form factor metrology sensor to follow a wafer’s path through the process.

The wireless inclinometer captured real-time measurements, including inclination, pitch and roll, as it moved from the FOUP to the robot end effector and into the vertical wafer boat. The device’s companion software displayed the metrology data on a GUI that allowed engineers to establish co-planarity among the tools, including the end effector’s five blades, wafer handoffs and perpendicularity of the wafer boat’s vertical path.

“Engineers loaded the device into the process and quickly saw which stations weren’t level and likely particle-contamination sources,” Jackson said.

Jackson said that engineers used the vacuum-compatible WaferSense® Auto Leveling System 2 (ALS2) to enter the diffusion furnace, without taking equipment offline, to establish co-planarity among the FOUP, wafer boat and z-axis path for wafers in and out of the furnace.

“You can’t make sure wafers traveling in a diffusion process are truly level without that kind of in-process perspective,” Jackson said.

The Bottom Line

The 300 mm fab used the wafer-like inclinometer to reduce micro scratches, particle contamination and wafer scrap that stemmed from the lack of co-planarity among the FOUPs, robot end effector and wafer boat in the vertical diffusion process.

The co-planarity established throughout the vertical diffusion process by the wireless sensor improved yield and compressed staff and equipment downtime for characterization, preventative maintenance (PM) and calibration troubleshooting. Engineers also used the device to re-calibrate uneven points in the process without taking the entire process offline.

“They identified and corrected any inclination issues before they became a real source of particle contamination and wafer damage,” Jackson said.

Engineers used the vacuum-compatible device to access and measure inclination at hard-to-reach points in the process, including inside crowded FOUPs, precise wafer boat position and inside the furnace.

Jackson added that engineers operating the diffusion furnace used the data to establish yield-based inclination tolerances and standards for each station to establish reproducible process and technician controls.

Engineers used the new empirical controls to prevent micro scratching of wafers and optimize the vertical diffusion process for optimal yield.