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Reports from the Fab

PECVD Team Improves Tool Availability 60%, Film Uniformity with Wireless Showerhead Gapping

The User

The team at a 300 mm fab that operates a plasma-enhanced chemical vapor deposition (PECVD) tool.

Working Through Multi-Step Hot Gapping

The fab's PECVD team wanted to reduce the 10 hours of tool downtime required to measure the distance between the chamber's gas showerhead and wafer pedestal to ensure uniform film deposition, particularly with newer dielectric films.

The legacy gapping method used by the team was an imprecise trial-and-error process that employed ceramic pucks and reduced tool availability for extended periods during characterization and maintenance.

The PECVD team determined that the multi-step process varied from tech to tech and wasn't repeatable, according to Allyn Jackson, customer support manager at CyberOptics Semiconductor. The legacy method was also dangerous and increased exposure to particle contamination as techs repeatedly opened and handled the hot PECVD chamber.

"They had to go through a lot of inefficient steps to get to final inspection," Jackson said. "And there was no real track record to indicate the measurements would ever be correct when they ended up there."

The labor-intensive legacy gapping method required techs to cool, vent and open the PECVD chamber and place three ceramic pucks on the hot plate inside.

The techs then closed, evacuated and heated the chamber to 400 degrees C before adjusting the showerhead to place it on all three pucks.

The techs finally cooled and vented the chamber, removed the pucks and restored the tool to productivity to run test wafers.

After a team of 3 to 4 techs completed the hot-gapping process, they examined the film thickness and uniformity. If the test wafers didn't pass film inspection, the team repeated the entire gapping process -- more than once in some cases.

The manual legacy gapping method also left the PECVD team without the metrics to improve the process or set reproducible controls.

“It was a really variable measurement process that relied on eye-balling the gaps,” Jackson said. “Each time they had to set the gap, they were basically starting over.”

Establishing Controls with Wireless Ambient Gapping under Vacuum

The fab’s PECVD team implemented a wireless, wafer-like sensor to qualify the device for measuring and setting gaps between the chamber’s gas showerhead and wafer pedestal under vacuum.

The team placed the 300 mm wafer-like device on the PECVD’s wafer pedestal. The device uses three capacitive sensors to measure the distance to a conductive electrode in three locations on the showerhead and returns real-time gap measurements to a GUI. The device’s companion software allowed the team to export logged gapping data as a CSV file.

The sensor gave the PECVD team the ability to measure a range of possible gaps -- depending on application and material -- and set gaps with an accuracy of up to a thousandth of an inch to meet tight film deposition and production tolerances at the 300 mm fab.

“The team used the software’s real-time view of the gaps to find and set the optimal distance between showerhead and pedestal,” Jackson said.

Jackson added that the team was able to measure gaps in a safer environment and reduce particle contamination exposure as techs worked with the chamber under vacuum and at ambient temperature – rather than heating it to 400 degrees C.

“They knew there had just been too many risks to the techs and the processing environment with hot gapping,” Jackson said.

The wireless sensor, the Auto Gapping System (AGS), gave the PECVD team a one-time gapping method that significantly reduced the time required to characterize and maintain the chamber.

The fab’s PECVD team decided, after qualifying the device, to order a minimum of three AGS wafers, Jackson said.

The chamber’s manufacturer ultimately recommended the AGS wireless gapping method as the best know method (BKM) for fabs to set precise gaps between the VECTOR chamber’s gas showerhead and wafer pedestal.

The Benefits

After a two-month evaluation of the wireless gapping method, the team reported that the wireless method reduced the time to maintain the PECVD chamber’s gap settings from 10 hours to 4 hours or less – a reduction of 60 percent. In addition, the wireless method typically required 1 tech instead of a team of 3 to 4 techs.

The PECVD team estimated that, conservatively, it could save 3,500 staff hours per year on preventative maintenance (PM) with the wireless method and perhaps as much as 7,000 hours.

“The wireless method increased availability of the chamber and reduced the tool’s overall cost of ownership,” Jackson said.

He added that the wireless method improved overall film uniformity during the process, including some newer dielectric films which require gap precision simply not possible with the legacy puck method.

The wireless device also gave the team the ability to use precise gapping data to identify trends and set repeatable process and tech controls for PECVD chambers.

“By using the wireless wafer-like gapping device, they are able to create a repeatable gap-measurement process that supported the tight tolerances for uniform film deposition,” Jackson said.

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