

APPLICATION NOTE

PROCESS MONITOR FOR VERTICAL POLY LPCVD

BACKGROUND

The poly LPCVD process is very sensitive to particle contamination, and with up to 150 wafers processed during a single run, it is critical to quickly detect excursions or else suffer catastrophic yield losses. The Stiletto® *in situ* particle monitor (ISPM) can be integrated with most vertical polysilicon LPCVD furnaces to provide early detection of particle excursions that cause yield loss.

HARDWARE CONFIGURATION

Installation of Stiletto on the vertical furnace can be accomplished by modifying the existing pump line to accept the sensor manifold. Typically the sensor is installed as close to the exit of the tube as possible, in front of any valves. The windows on the sensor have a mean time between failure of > 6 months.



Figure 1 - Stiletto installed in the exhaust of a vertical poly furnace.

DATA COLLECTION AND ANALYSIS

The FabGuard® Sensor Integration and Analysis System is used to integrate Stiletto *in situ* particle data with tool information to provide enhanced data analysis and tool control.

Stiletto data is collected from the boat push through the boat pull. Tool parameters such as gas flows, pressure and recipe step can be overlaid with particle data to provide timing information, which is key to identifying particle sources. Figure 2 shows a typical profile of particle counts during a furnace run.

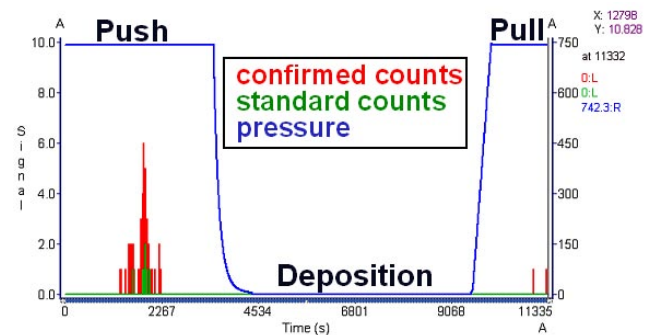


Figure 2 - Profile of a single run showing counts occur mostly during boat push

In Figure 2 a majority of particles are detected during the push of the boat into the furnace. Particles are liberated from the furnace walls during the push due to the thermal stress generated by putting relatively cold wafers into a hot tube. There is also good particle suspension during the push step, which allows the particles to be transported to the sensor where they can be detected.

During each run, the total particle levels are recorded, and then tracked over time to identify changes in the process and hardware condition. Figure 3 shows the total count trend of the *in situ* particle counts detected by Stiletto for a one-month period on a vertical poly furnace. There is a baseline count rate showing that particle levels are typically less than 10 per run as detected by Stiletto. There are also several

runs that show higher count levels, indicating particles are flaking off the surfaces inside the furnace. The high count excursion on 08/05 corresponded with the last run prior to a boat change. The following run, showed normal count levels, indicating the boat was the source of the higher count levels.

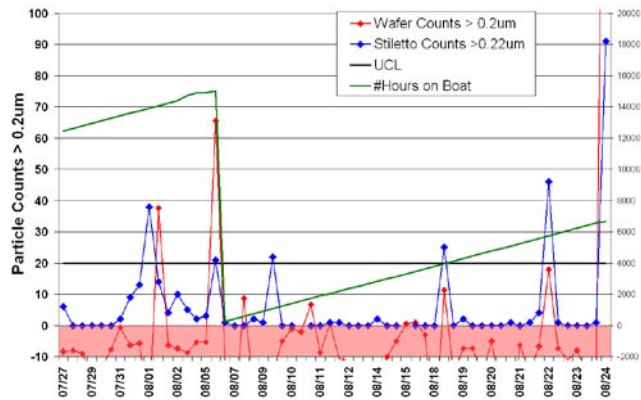


Figure 3 - Monthly trend of *in situ* and *ex situ* particle counts for a vertical poly furnace

Three particle test wafers are processed with each run and Figure 3 shows the average counts for these test wafers plotted for each run. Each test wafer is measured prior to the deposition, and then again post-deposition. The total count for each test wafer is the difference of the pre- and post-measurement. Notice that quite often there are less particles measured after the deposition, than before (negative total counts). Some particles measured pre-deposition are masked during the poly deposition step, creating the negative count numbers. The *in situ* particle counts and the *ex situ* test wafer counts both identify the same runs as having elevated counts.

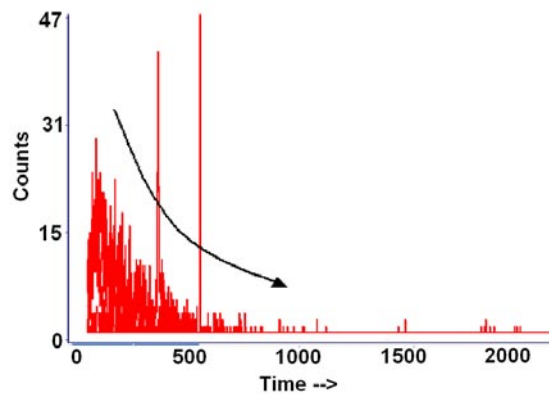


Figure 4 - *In situ* particle counts during conditioning run after maintenance events

The Stiletto sensor can also be used to monitor and optimize the chamber conditioning process performed after routine maintenance and hardware changes. Figure 4 shows the *in situ* count trend detected during the chamber conditioning process. By using Stiletto to determine when the counts are back to baseline, it may be possible to save up to 1000 seconds per conditioning run.

CONCLUSION

The Stiletto *in situ* particle monitor can be integrated to most vertical poly furnaces to provide real-time particle data for process control. It can also identify process runs with elevated counts to increase yields, determine when particles are generated to reduce downtime, and optimize conditioning runs for improved productivity.



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