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Real-Time Arc Detection for FDC – Craig Garvin

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Shrinking critical dimensions dramatically increase device sensitivity to plasma arcing. A process that resulted in acceptable yield can result in excessive particle contamination at the next technology node. The source of particles can be identified as plasma arcing at device metrology, but beyond that, nothing can be done to mitigate or prevent the problem. Recent advances in miniaturization, high-speed data acquisition, analysis, and FDC integration make it possible to monitor plasma arcing in real-time. As a result, instantaneous information on device damaging arcing can now be incorporated into line-level and fab-wide FDC. Arc detection is possible in RF, DC and mixed-mode plasmas.

Low-Cost Non-Intrusive Sensor for all Applications

Conventional RF Sensors are bulky and difficult to install. Furthermore, conventional RF Sensors act as a significant impedance load on the RF circuit and can perturb delicate match tuning. This size is largely due to a historic focus frequency discrimination and accurate power measurement. We will show data indicating that arc detection is possible using a far simpler magnitude sensor, thus permitting monitoring of a much wider range of chambers than previously possible.

In many cases, DC arc detection can be achieved with only a signal splitter. In the cases where additional sensing is required, a readily mountable split-coil current clamp is used.

Ultra-High Speed Data Acquisition

Plasma Arcing is an extremely high-speed event. Until recently, arcing could only be monitored with lab equipment that was not compatible with a production environment. We will show data illustrating the range of time scales associated with arcing signals.

Powerful Signal Processing and Analysis to Eliminate False Alarms

A wide range of transient events take place in an RF plasma. Only a few of these are associated with device damage. We will show examples of arcing related and other RF transients, as well as the signal processing and analysis used to differentiate these two.

Conditional Data Saving for Scalability

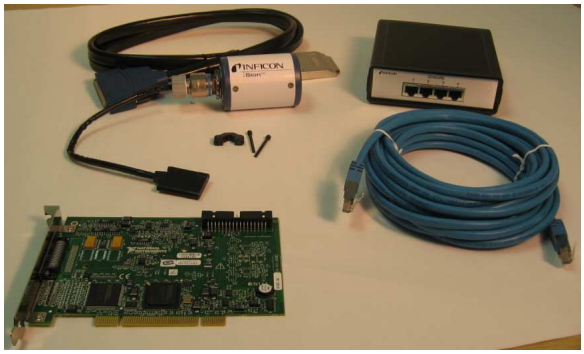
High-Speed Raw Data is valuable both for tuning analyses as well as for confirming alarms. However, saving all High Speed data is simply not manageable in a line-wide deployment. We will illustrate algorithms to trigger conditional saving and discuss trade-offs between space saving and analysis.

Powerful FDC and FDC Integration

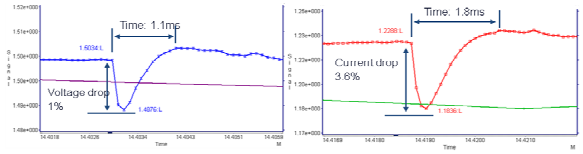
A number of different summarizations are required to accurately correlate individual arc events to particle damage. In some cases a single arc event of a certain magnitude is the signal. In others, the total number of events during a run must exceed a threshold. Illustrations of these and other indicators will be presented.

Results on Real Processes

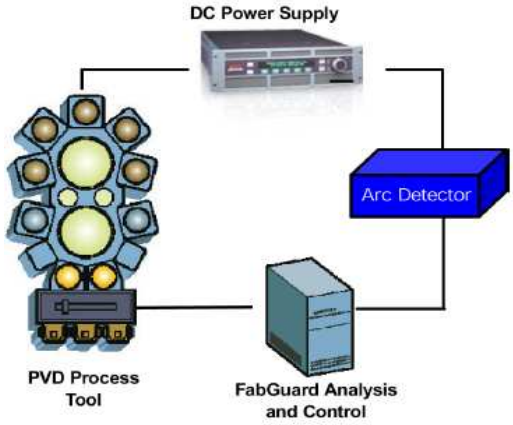
We will present results showing strong correlation between real-time arc detection and ex-situ metrology. In order to achieve this correlation, process-specific analyses must be configured based on representative performance.
Conclusion



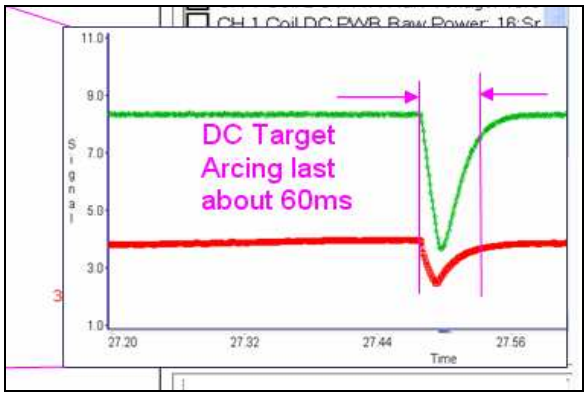
RF Sensor System – One Chamber



Represent Arc Signal on RF Current & Voltage



DC Sensor System – One Chamber



Representative Arc Signal – DC Voltage & Power