Impact Oriented Fault Detection and Classification for Litho Process Monitoring

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Recently multivariate process control and data analysis techniques such as PCA-based T2 control chart have been employed for process monitoring, yield improvement, tool diagnosis, and process fault detection. The technique is good at detecting out-of-control (OOC) signal among multivariate variables and finding root causes of the abnormal condition statistically. However, a lot of OOC's are only statistically correct, but are not meaningful to engineers because they may not have any impact to the end-of-line results. So engineers don't care about those OOCs and treat them as "false alarm" even though they are truly statistical OOCs.

The above problem with PCA-based multivariate SPC charts such as T2 chart and SPE chart shows that the impact of the flagged OOC is not clear. For example, an OOC in multiple dimensional equipment data detected by T2 chart may not have any impact to the downstream metrology data or performance data. On the other hand, variation of different parameters may have different level impact to the downstream parameter.

To solve the problem, we used the weighted FDC to handle the differences in parameter impact to the downstream data. A detailed procedure of weighted FDC was developed to integrate the process prediction and the weighted FDC fault detection and classification method together. The method was applied to lithographic process monitoring to detect issues on scanner.

The procedure has been applied to several real cases. The benefits of this methodology include integrating parameter importance factor in the fault detection, combining cause-effect with multivariate fault detection to increase the clarity of process data impacting on product performance, giving quicker detection and alarm on process fault, and simplifying the troubleshooting procedure for process engineers and device engineers.