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Invited Speech: Beyond Traditional Advanced Process Control

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About the Speaker

Dr. James Moyne is a consultant for standards and technology to the Applied Global Services group at Applied Materials, as well as an Associate Research Scientist at the University of Michigan, where he received his PhD. Dr. Moyne has experience in smart manufacturing, prediction, and big data technologies; he is the author of numerous publications and holds patents in each of these areas.

Dr. Moyne has been the technical chair of the APC conference in the U.S. since 2012 and has co-authored SEMI standards in the areas of process control (including E133 and E126), sensor bus (E54), and big data (E148 and E160). He is the lead author of Run-to-run Control in Semiconductor Manufacturing and is currently co-chair of the North America SEMI Information and Control Committee, SEMI process control systems and sensor bus task forces, and the International Roadmap for Devices and Systems (IRDS) Factory Integration working group.

Abstract

The microelectronics industry continues to follow the big data revolution and adopt Smart Manufacturing (SM) and Industry 4.0 strategies. These strategies use improved integration and analytical capabilities in important areas including Advanced Process Control (APC) to deliver opportunities for improved yield and throughput and reduced cost. SEMI defines APC as "…the manufacturing discipline for applying control strategies and/or employing analysis and computation mechanisms to recommend optimized machine settings and detect faults and determine their cause." Thus, both run-to-run (R2R) control and fault detection and classification (FDC) technologies are considered part of the APC family. As we explore the tenets of SM, both R2R control and FDC surface as key components of the SM movement. Each enables aspects of SM, but also benefits from that same movement to provide improved APC solutions.

From the perspective of SM, R2R control can be considered part of the SM "digital twin" (DT) tenet. According to Wikipedia "A digital twin refers to a digital replica of physical assets, processes and systems that can be used for various purposes." R2R control is a process DT because it typically uses a model of a process, updated on a run-to-run basis, to improve process capability. Given the pervasiveness of R2R control in microelectronics, we can say that the industry is already successfully employing DT components fab-wide. As we begin to embrace SM

strategies more fully, R2R control solutions will become more precise, robust (from a control system definition perspective) and granular, and will be more integrated with each other (e.g., for improved chamber matching), as well as with other DT components (e.g., with scheduling and dispatch DT models for improved yield-throughput optimization of process flows).

FDC is typically used to create actionable information from trace data collected from equipment. From an SM perspective, FDC and the FDC data collection infrastructure are key components of predictive solutions ranging from predictive maintenance to virtual metrology and yield prediction. FDC is being enhanced to support these predictive solutions, but also to improve fundamental FDC capabilities by enhancing detection accuracy and reducing FDC setup and maintenance costs.

This presentation explores the evolving role of APC in the smart microelectronics manufacturing movement, highlighting the enhancements to APC capabilities to support SM strategies as well as integration of these APC capabilities to provide new opportunities to improve throughput and yield and reduce cost. Finally, it describes new APC technologies and technology directions in SM and provides case studies to illustrate potential benefits.