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Dynamic Bayesian Network-Based Run-to-Run Control Scheme for Optimal Quality Engineering in Semiconductor Manufacturing

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Run-to-Run (R2R) control has been used for decades to control wafer quality in semiconductor manufacturing, especially in critical processes. By adjusting controllable variables from one run to another, quality can be kept at desired levels even as the process conditions gradually change, such as equipment degradation. The conventional R2R control scheme calculates the adjustment value for the next run primarily based on output quality measurement, which may provide delayed information and fail to reflect real-time process shifts. Nowadays, advanced process equipment is equipped with numerous sensors to collect data and monitor process conditions. Sensor data are also extensively utilized for various process-related tasks, including quality prediction or fault diagnosis. In this research, we propose a novel R2R control scheme that incorporates more timely control by considering uncertainties and relationships among sensor data, controllable variables, and target variables to enable online R2R control. Dynamic Bayesian Networks (DBN), which serves as the core of the R2R control scheme, graphically links all variables from different time periods. Network connections can be learned from historical data and also imposed based on known causal relationships. By leveraging the information from the previous run and the desired target value, the particle-based method is employed to compute the optimal control settings for the upcoming run using the trained DBN. Finally, the performance of the proposed approach is evaluated using real-world data.

Keywords

Process Control, Dynamic Bayesian Network, Semiconductor Manufacturing

Classification

Mainly application

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