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R2R Control of a Chemical-Mechanical-Polishing Process Based on Machine Learning Techniques

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The high level of automation, the process miniaturization, the multiple consecutive operation steps, and the permanent entrant flows make the semiconductor manufacturing one of the most complex industrial processes. In this context, the development of a Run-to-Run (R2R) controller that automatically adjust recipe parameters to compensate for process variations becomes a top priority.

Since the current system corresponds less and less to the operational requirements, we aim to take advantage of the large amount of available data and computing power to deploy a controller based on Machine Learning techniques. However, in an industry where both efficiency and interpretability are essentials, we must favor models that allow for root-cause variability analysis among time. Therefore, regression tree-based models have been retained in our approach, which consists of three major procedures: due to the multitude of parameters related to each wafer, a multivariate statistical analysis is preliminary performed to identify which features determine the process output. A Random Forest model which relates the relevant variables with the output is then trained off-line from historical data. Whenever wafer information is collected on-line, the predicted output is used to determine the right recipe parameter, the measured output is collected, and the model updated.

Numerical experiments are today conducted on a Chemical Mechanical Polishing operation of a key technology. The performance of a Random Forest model trained at wafer-level will be compared with the batch-level model implemented in the current system, in term of variance reduction of the output parameter, and will be presented in June.

Keywords

Run-to-Run (R2R); Machine Learning; Chemical Mechanical Polishing (CMP)

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