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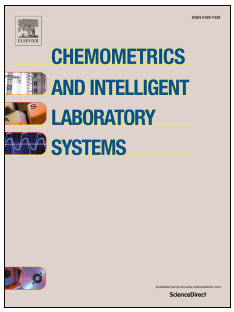

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PII: S0169-7439(18)30096-0

DOI: 10.1016/j.chemolab.2018.08.005

Reference: CHEMOM 3665

To appear in: *Chemometrics and Intelligent Laboratory Systems*

Received Date: 6 February 2018

Revised Date: 3 August 2018

Accepted Date: 12 August 2018

Please cite this article as: X. Zhang, Y. Li, Multiway principal polynomial analysis for semiconductor manufacturing process fault detection, *Chemometrics and Intelligent Laboratory Systems* (2018), doi: 10.1016/j.chemolab.2018.08.005.

Multiway principal polynomial analysis for semiconductor manufacturing process fault detection

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Abstract

In semiconductor industry, the etching process is a highly sophisticated nonlinear process, which significantly affects the wafer quality. Fault detection technique has been investigated as a promising tool to reduce the fault wafers and increase overall equipment effectiveness. However, traditional fault detection models are not adequate enough to describe the etching process due to the high complexity and non-linearity of wafer processing process. In this study, a novel fault detection technique called multiway principal polynomial analysis (MPPA) is proposed. MPPA is a nonlinear modeling technique which learns a low-dimensional representation from process data based on a sequence of principal polynomials. Compared to linear methods, MPPA is more flexible and efficient in tackling process nonlinearity. Furthermore, MPPA has the desirable properties of invertibility, volume-preservation, and straightforward out-of-sample extension, thus making it interpretable and easier to implement in real application. To verify the effectiveness of the proposed MPPA, it was applied to a nonlinear numerical example and the real-world operation data of a semiconductor manufacturing process. The application results demonstrated that the proposed MPPA method outperforms the conventional MPCA, FD-kNN, and PC-kNN in the fault detection performance.

Keywords: Fault detection; batch process monitoring; multiway principal polynomial analysis; semiconductor manufacturing.

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