Full-line FDC Diagnosis System via Signals Similarity Measure

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Abstract

In semiconductor manufacturing, FDC (Fault Detection and Classification) evolved from the early EMS (Endpoint Monitoring System) that was an embedded fault detection system applied on single wafer plasma etchers [l]. The first task of FDC is fault detection, which finds the anomalies from pre-defined normal state. Afterwards, the next task of FDC is fault classification, which specifies the possible causes of a fault and determines the effect of the fault on the wafer state. With the multiplicity of sensor signals provided by process sensors, the chance of detecting faults is significantly increased [2-4]. However, we have used SEC (Smart Equipment Control) analysis module on FDC system for single tool. There is still few powerful techniques for monitoring multi-processes production in fabs.

Generally speaking, engineers analyze the probable root causes of tools by FDC system. Engineers will plot charts of all suspicious parameters to find root causes by querying numerous data. However, the current used techniques have difficulties to handle with ever growing data and to solve the newly emerging problem(s). It indeed requires manpower and consumes time. Meanwhile, the same bad lots would be produced continuously or sporadically. Therefore, to simplify and sift data is needed to improve the efficiency of finding root causes.

SAX (Symbolic Aggregate ApproXimation) approach transfers time serial signals into symbols by allowing a time series of arbitrary length to be reduced to a compound string. It performs well in dimensionality/numerousity reduction and lower bounding [5-6]. It can exactly help handle the huge data behind FDC system. Based on SAX transformation method, a symbolic set will be generated from signals to strings (Figure 1). Afterwards it will be put in order as symbolic array (Figure 2). Finally, the specific process production of each wafer can be recorded all in terms of the symbolic set. We compare the Good/Bad wafers pattern (symbolic sequence array) using distance measures in SAX and provide severity ranking report to assist engineers in trouble-shooting daily jobs. This procedure and the ranking report are displayed in Figure 3.

The method proposed in this paper has two features. One is the improvement in the distance measure in SAX. The other is the on-line production wafer comparison. SAX requires that the measurement data be in Normal distribution, which cannot occur in all cases. This paper proposes a robust method to check it the measurement data is in Normal Distribution, and then transfer them to Normal Distribution if they are not. With the proposed on-line production wafer comparison, engineers can find tool root causes quickly, especially for tough and vogue cases. This speeds up the root cause finding and improves the accuracy.

References

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[Appendix]

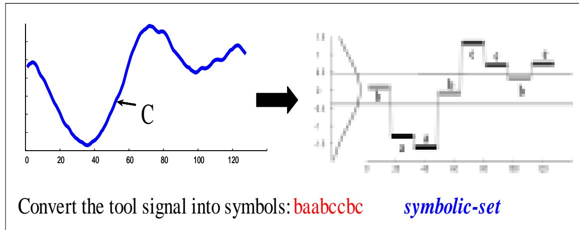

Figure 1: Generate symbolic set from one signal.

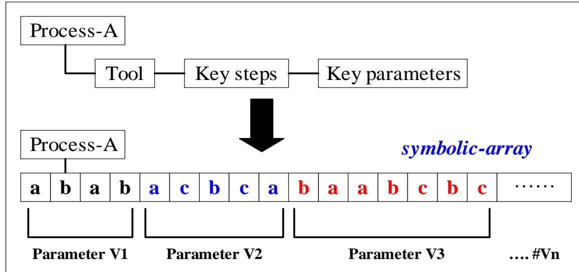

Figure 2(a): Generate symbolic array from one process.

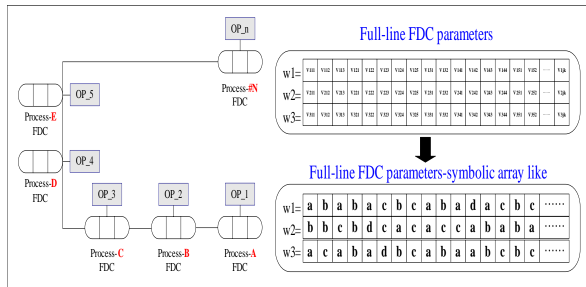

Figure 2(b): Full-line FDC transformation to symbolic sequential array.

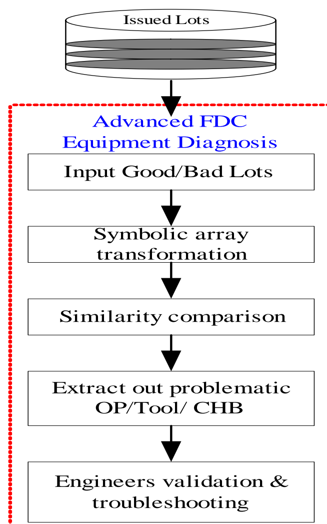

Figure 3(a): Analysis flow of this research.

Top	Etching Tool Parameter	Severity value
1	ESCCurr	2.12092
2	GASFlow9_O2	1.92248
3	GASFlow12_Ar	1.81398
4	He_outer_flow_rate	1.75695
5	He_outer_leak_rate	1.50695
6	GASFlow11_CF4	1.48749
7	ThrottleVlv	1.46583
8	GASFlow1_Cl2	1.43085
9	Escorts	1.40654
10	He_inner_pressure	1.40484

Figure 3(b): The severity ranking results of fault diagnosis.

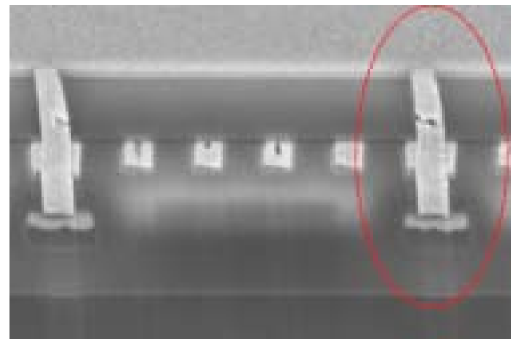

Figure 4: The PFA(Physical Failure Analysis) data of study case.