Fault Detection in Semiconductor Manufacturing Using Statistical Method

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Abstract: Fault detection is necessary for yield enhancement and cost reduction in semiconductor manufacturing. Sensory data acquired from the semiconductor processing tool is too large to analyze for the purpose of fault detection and classification (FDC). We studied the techniques of fault detection using statistical method. Multiple regression analysis smoothly detected faults and can be easy made a model. For real-time and fast computing time, the huge data was analyzed by each step. We also considered interaction and critical factors in tool parameters and process.

Key Words : Data processing, FDC, multiple regression

1. Introduction

Data mining is the knowledge discovery in databases. In semiconductor manufacturing, fault detection by data mining is necessary for good yield. For manufacturing diagnosis, there are using hundreds and thousands sensors in a fabrication facility. The sensors represent the operation condition of equipments. The research of data processing, however, is studied through just numbers. Missing critical factors and interaction is sometimes a big problem. Data preprocessing should be considered roles and interaction of equipments in tools and process.

2. Data Preprocessing

A tool was DPS-Ⅱ silicon etcher of Applied Materials. Data from the tool had 150 system variables, 10 Hz frequency, and 11 steps. There are 10 model runs and 10 experiment runs with 7 faults.

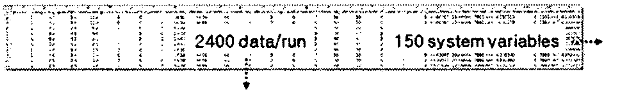

Figure 1. Real-time tool data has about 2,400 data points per single run 150 system variables.

In the other fault detection study, it is concerned only the data without the features of tools and process. We clustered the data by correlation study.

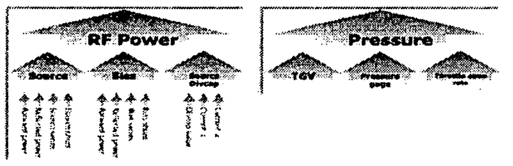

Figure 2. Each group represents the relationship of tool parameters.

3. Data Mining

For real-time and fast computing time, the data was separated by each step. There were 8 variables related to pressure. We made the pressure model using statistical method, multiple regression analysis.

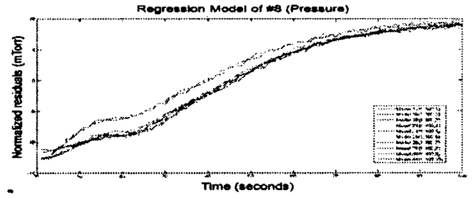

Figure 3 The pressure model of step 1 using multiple regression analysis.

4. Result

When the summation of experiment data was not equal to that of model data, we classified it into the fault group. 4 experiment runs had pressure problems. Actually, FDA_15 and FDA_17 was induced ±0.5mT change to base pressure. FDA_20 and FDA_23 was also induced ±1% MFC conversion shift.

Experiment related to the pressure

	Step 1	Step2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step 11
FDA_14	0.170686	1.163555	0.241521	-1.25201	-8.73967	-7.28016	-0.21126	0.013961	-5.47124	119.2819	-7.644655
FDA_15	1.696968	1.59251	-0.10684	-0.74995	-31.7755	-10.0618	0.811224	0.009726	-14.7135	122.2854	-5.988506
FDA_17	1.619477	0.809615	0.511253	-0.94402	-1.30963	-9.67016	-1.34652	-0.09548	-15.5664	101.2942	-6.089571
FDA_20	0.145957	-0.39234	0.257859	-1.56341	8.260856	-6.14026	-0.1285	-0.17355	-73.3306	157.5454	-5.287361
FDA_23	0.878056	2.542568	0.007458	-0.02586	-44.3649	-11.1832	-0.16588	0.068359	59.56539	77.54918	-7.891479
FDA_25	1.74898	1.041398	0.091252	-1.04271	-14.6975	-8.11851	0.023438	-0.01522	-6.93267	101.5896	-6.174097
FDA_31	0.033003	1.11703	0.205226	-0.77613	-14.3961	-9.12524	0.089594	-0.05353	-4.93918	119.7249	-7.911203
FDA_34	-0.01032	1.206682	0.130045	-0.37162	-4.52612	-10.1594	-0.08896	0.02026	-5.36345	106.275	-6.088651
FDA_38	0.003881	1.103557	0.217172	-1.30997	-13.9984	-8.18016	-0.13765	-0.00201	-8.39082	79.56575	-7.536669
FDA_43	0.504087	1.15424	0.171675	-0.92814	-15.3559	-8.13109	-0.07234	-0.0428	-5.46752	115.1956	-6.14474

Table 1. The result of experiment data using multiple regression analysis.

5. Conclusion

This paper suggests the method of fault detection in semiconductor manufacturing. Regression can be useful for the represented model of whole tools and process. It is able to classify the data into each group of process and equipment. We will study other parts of process soon such as RF power, gas, and ESC.

References

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