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Equipment internal action and productivity analysis
Loss analysis concerning 1st Wafer Delay using log file of photolithography machine

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1. Introduction.

This short article illustrates the benefit of using detailed Equipment Engineering System (EES) data analysis to expose undesirable production losses due to First-Wafer-Delays (FWD) in exposure machines. In general, production loss is caused by the frequent need to prepare for and change recipes and reticles for multi-product production. By collecting and analyzing EES data for a multi-product Fab, the process delay-time resulting from that need can easily be shown. The First-Wafer-Delay impact is clearly illustrated below in Figure 1.

2. Problems of identifying and tracking (Visualization) FWD.

Identifying and tracking individual wafer progress in exposure machine can be very difficult because the management of most tool processes is at the lot level. Simple examination of tool operation and improvement efforts may not be enough to show true improvement potential. Especially for equipment with many complex operations (like the single-wafer type), it was necessary to analyze each wafer's process time using EES to discover and "Visualize" production losses.

3. Method of FWD "Visualization" technique.

Step1: Data to be analyzed is decided from the product kind, product model, product step, process recipe, and the machine.

Step2: The event log and its generation order are extracted from the EES data (Figure 2). The event log shows the wafer movement and the processed status change.

Step3: The processing switch timing of the career and the lot is extracted from the data of Step2.

Step4: The elapsed time of 1st Wafer's movement and processing state transition's are compared with that of the stationary state since 2nd Wafer. The time difference is defined as FWD, and is plotted.

Step5: The variation in FWD is carefully observed (Figure 3), and FWD is classified into some groups according to the variation.

Step6: Each lot group classified in Step 5 is analyzed for the cause of the variation from an equipment operation effect and an equipment hardware effect.

4. Analysis of FWD.

The distribution of FWD in the exposure machine obtained by using the technique mentioned above is shown in Figure 3. The resulting FWD can be classified into three groups.

(a) FWD was 190 seconds or more; a long delay with a big difference from the other wafers.

(b) FWD was a long group of 190 to 260 seconds.

(c) FWD was a short group of 100 seconds or less.

The analysis of each FWD group and remedy are shown below.

Group (a):The log that executed assistance was found commonly and it turned out that about 80% was operator's confirmation waiting for the result of reticle particle inspection. This FWD can be reduced by understanding and standardizing the operator's work flow.

Group (b):The lots in which the reticle exchange was executed belonged to this group. Remedies were found from the analysis of group (c).

Group (c):The lots in which the reticle particle inspection was executed before starting the lot operation were in this group. This is an ideal state of the equipment production efficiency. The effect of operation that shifted group (b) to group (c) became clear.

Analysis of the difference between machines:

The machine difference of FWD was found from the detailed analysis (Figure 4). The cause was a difference in the reticle transportation time. The problem influenced by hardware was easily identified.

5. Conclusion.

Using the simple method described above, First-Wafer-Delay (FWD) can be easily classified into several logical groups. Cause and effect can be classified, and remedies were proposed for each case. The analysis method "Visualizes" production losses on exposure machines, and can help lead to the realization of true productivity improvements. The exposure machines are complicated tools which control several reticles and wafers at the same time. In addition to studying these complicated tools, this type of analysis method would be useful for analyzing many other types of tool.

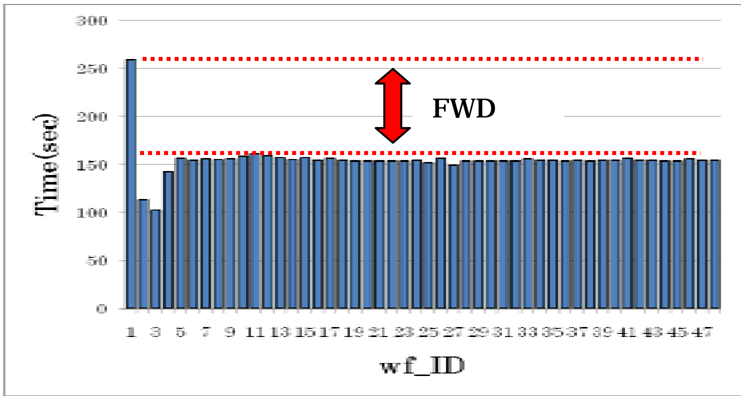

Figure 1　FWD seen at wafer processing time in lot

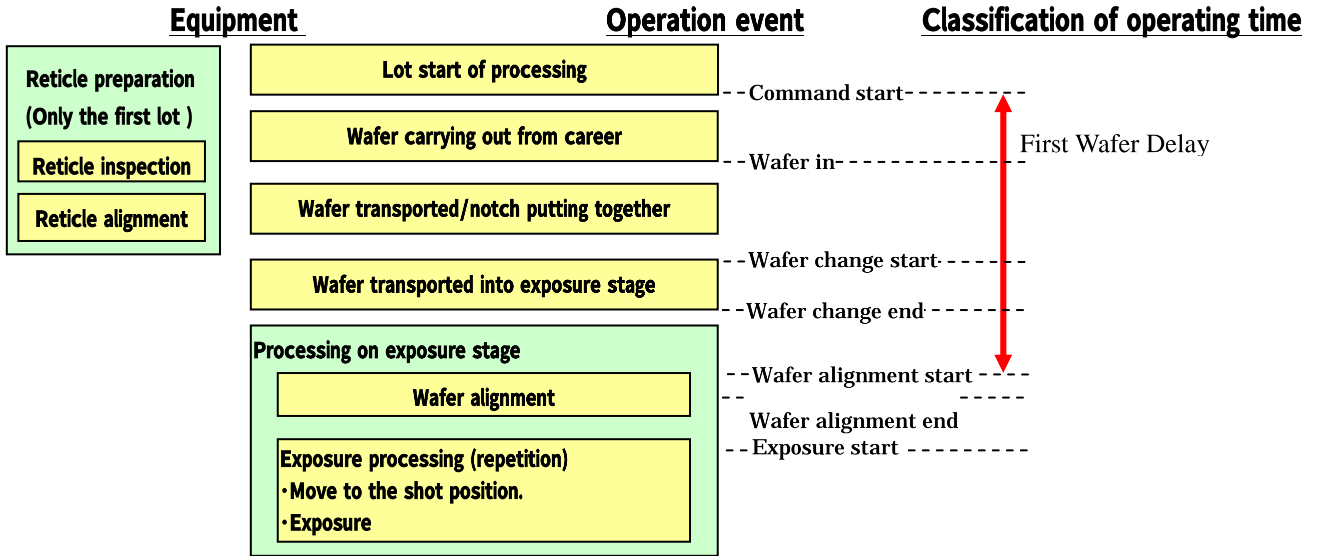

Figure 2　Standard processes in exposure machine

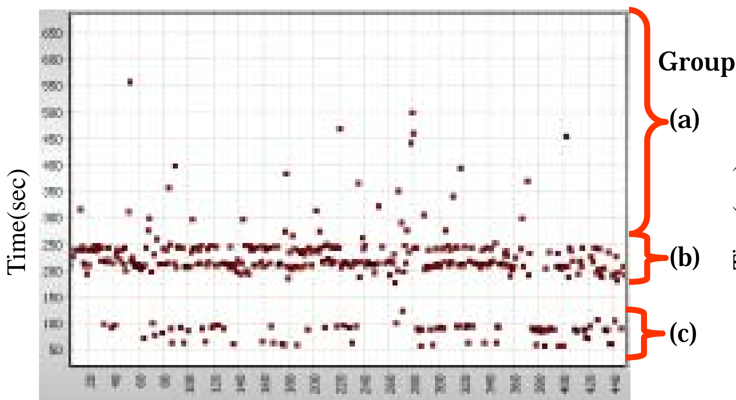

Figure 3　Distribution of time of FWD time

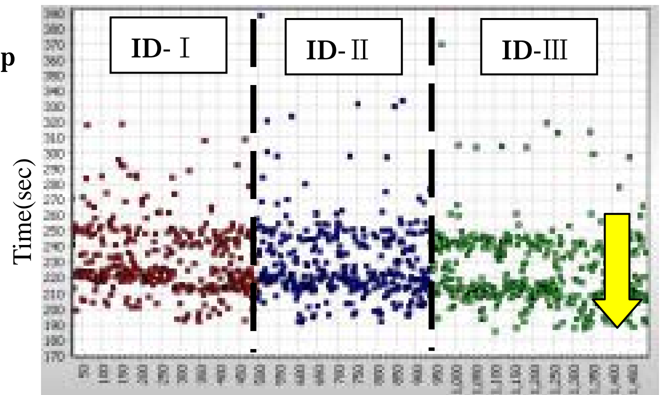

Figure 4　FWD machine difference of group (b)