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DEVELOPMENT OF SIMULATION-BASED SCHEDULING SYSTEM FOR BACK-END SEMICONDUCTOR FOUNDRY

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ABSTRACT

The manufacturing processes of semiconductor foundry (FAB) are grouped into two, and they are called as the front-end processes and the back-end processes, respectively. Due to the development of semiconductor technology, the back-end processes have become more complex according to the new requirements of customers. In this presentation, a simulation-based scheduler is introduced which is highly customized to a Korean back-end semiconductor foundry. The different heuristic dispatching rules considering various practical constraints are applied to different processes, and the preliminary experiments indicate that the system is efficient in the pilot line.

1 INTRODUCTION

The manufacturing processes of semiconductor foundry (FAB) are grouped into two, and they are called as the front-end processes and the back-end processes, respectively. Wafer is produced in the front-end processes. In the back-end processes, various semiconductor chips are produced by various operations using wafers, and sometimes they are called as packaging processes. Due to the development of semiconductor technology, the back-end processes have become more complex according to the new requirements of customers. Recently, multiple layered (stacked) chips have become popular as the increasing trend of higher capacities and condensed sizes.

The facilities of front-end of FAB are highly automated and capital-intensive. Furthermore, there exist various constrains such as re-entrant process flows, alternate or designated machines and so on. Thus, higher utilizations of resources, just-in-time production for on-time delivery with minimum WIP (work-in-process) are main concerns in FAB industry (Ko et al. 2010). These complexities are the main reason that semiconductor foundries have interests in developing their own scheduling system for the front-end of a FAB. Unfortunately, the scheduling system of the back-end processes has not received much attention, because the facilities are not perfectly automated, the constraints are more complex and the value added in the back-end is much lower than that of front-end.

The scheduling problem in FAB can be categorized as a flexible job shops scheduling problems (FJSSP) with various constraints. Three typical approaches have been applied to the FAB scheduling, and they are optimization, simulation and AI (Artificial Intelligence). Optimization approach finds an optimal schedules for a given time bucket using mathematical models. On the other hand, simulation approach determines schedules using customized simulation models and dispatching rules (Ko et al. 2010). The third approach is AI that is of interest recently (see Senties et al. 2010; Shiue et al. 2018). However, most of previous researches have focused on the front-end of FAB.

2 CHARACTERISTICS OF BACK-END PROCESSES

The major processes of back-end in FAB are back grinding, die attaching, wire bonding, molding and various inspections. Figure 1 shows an example of the routings of the certain type of chip which consists of five stacks. Then, there are five die attaching operations and two wire bonding operations, and the total number of detail operations in this routing is 37.

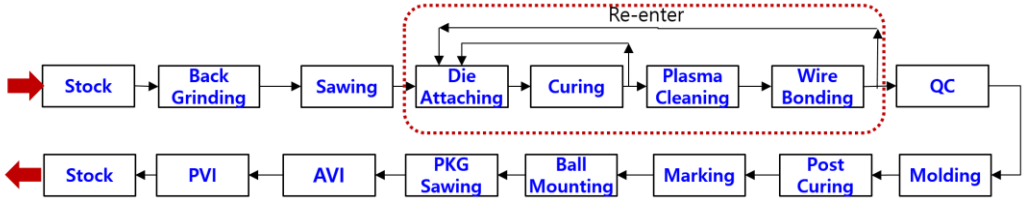

Figure 1: Example of a back-end processes.

Lot splitting/merging and lot chasing are constraints for developing scheduling system for the back-end processes. The wafer is supplied from the customer by carrier (called as FOUP) and the transportation devices are changed to cassette, container and tray during the routing. In wire bonding operation, a lot finishing die attaching operation is split into many for reducing the lead time, and the split lots are combined after finishing the wire bonding operation. Time window allowed for the next operation is another constraint of scheduling. There are various other constraints that we should consider for developing scheduling system such as AGV and the number of setup tools necessary for a chip.

3 SIMULATION-BASED SCHEDULING ENGINE

We are developing a simulation-based scheduling engine which is highly customized to a Korean back-end FAB. Simulation model is developed with ARENA, and the different dispatching rules considering various practical constraints are applied to different processes. The main objective is to minimize TAT (Turn Around Time). In the preliminary experiments on the pilot line which consists of 12 die attaching machines, 72 wire bonding machines, curing and plasma cleaning machines, the TAT can be reduced about 5~10%.

The final goal is that more than seven hundreds machines can be controlled by the system developed. The scheduling engine would be interfaced with existing ERP and MES systems, and the re-scheduling time should be 1~2 hours.

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