SCHEDULING IMPLANT OPERATIONS USING CONSTRAINT-BASED SCHEDULING

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Abstract:
Our presentation describes recent work on implant scheduling that was undertaken in collaboration with Intel Ireland. The purpose of implant operations is to introduce dopant atoms into the silicon to create conducting areas.

The implant tools consist of a source element that emits a high energy beam through a cloud of ions. The source is much like the filament in an old fashioned light bulb. There is one important difference however: whereas the filament in a light bulb degrades over time, the source filament grows or decays depending on the type of ions that are being implanted. It is therefore important to assign the operations in particular way to each machine, in order to prolong the life of the filament. Unfortunately, changeovers between different types of ions are expensive, as they lead to significant downtime of the tool.

Constraint-based scheduling is a technique that works by modelling the constraints on possible schedules. The model also includes the types of tools and their specifications, the orders that are to be processed, the rules that govern changeovers, etc. Specialised algorithms can then generate schedules that adhere to all the constraints, optimising for a given cost-function.

Using Ilog OPL Studio, we built two (deterministic) constraint-based scheduling models that can schedule the operations for a set of implant tools over a given time period. (They differed in the way that pairing of wafers onto machines is handled.) Given actual data from Intel, we studied the quality of the two models (called '3' and 'p' in the graphs) and analysed their performance. We then used the better model ('p') to investigate two what-if scenarios. The first saw the number of operations doubled or tripled, while the number of tools remained the same. This gives an idea of the total capacity of the current tool set. The second scenario explored increasing or decreasing the number of tools under the current load. As one can expect, more tools mean a higher throughput and lower buffer times. We can also observe diminishing returns on additional tools, as there are not enough operations to keep all tools occupied.

After promising initial results, we are hoping to carry this work further. Specifically, we are looking into the integration of scheduling and simulation techniques to better deal with the stochastic nature of the process.

Keywords:
Constraint-based scheduling, semi-conductor industry

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