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Tool planning model with calibration for semiconductor equipment manufacturer

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Abstract

This research is motivated by issues to confront with a manufacturer of semiconductor equipment. In producing semiconductor equipment, the number of tools which sent back to the supplier for calibration is different each month. It causes the production tool shortage problem. In order to avoid the shortage problem, the number of calibrated tools each month should be concerned when scheduling the tool. However, previous researches less consider the capacity of tool supplier calibration in calibration cycle time. This research is mainly to solve the tool reuse after calibration and supplier calibration capacity in calibration cycle time problems. This research is to develop a tool planning model with tool calibration quantity balance monthly. This model balances the calibrated tool quantity every month. Furthermore, the development of heuristic provides an effective way to minimize the number of tools shortage under orders satisfaction.

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Keywords: Tool planning, Semiconductor, Tool calibration

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1. Introduction

The semiconductor manufacturing process can be divided into four basic steps: wafer fabrication, wafer probe, assembly and final testing. Wafer fabrication is the most complex in manufacturing technology and it is capital intensive of four phases [1]. With the advancement of manufacturing technology, the size of the chip is getting smaller as shown in Fig. 1[2]. The accuracy of manufacturing is important as the size of the chip getting smaller. The manufacturing tool must be accurate when manufacturer products equipment.

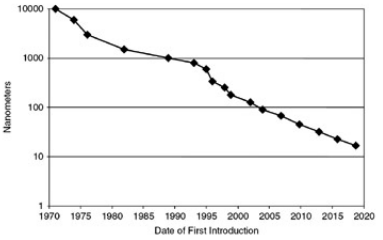

Fig. 1 wafer size with time

The accuracy of the measuring tool is important. The tool must be calibrated periodically for high accuracy. The tool planning mixed calibration problem is similar to preventive maintenance. Production scheduling with preventive maintenance are the common problems in the manufacturing industry. In the past scheduling with preventive maintenance studies, maintenance activities can be divided into two types: fixed and flexible[3,4]. In fixed type, the maintenance periods are known and fixed in advance. Sun and Li proposed a scheduling problems which has multiple maintenance activities and non-preemptive jobs on two identical parallel machines. The maintenance activities are performed periodically and the objective is to schedule the jobs on two machines such that the makespan is minimized[3]. In the flexible type, the maintenance periods are also decision variable. [4] Vahedi Nouri, Fattahi et al. proposed the non-permutation flow shop scheduling problem with learning effects and flexible maintenance activities. Each machine has maintenance activities that should be finished within specific time intervals. In this paper, there is consider that maintenance activities are flexible.

The tool planning problem determines how tools should be allocated to each order to meet some objectives[5]. However, there are some problems in tool planning. The problem for the cases of uncertain demand and cycle time constraints still need to be solved. In tool planning, tool useful life is critical. The accurate assessment of remaining useful life (for reuse) of any given tool is important in any manufacturing industry[6]. [7] Ji-Wen, Li-feng et al. proposed three maintenance policies with consideration of both component catastrophic failures, the interdependence of component degradations on the product quality loss, and the obsolescence cost. Yet, most of them do not involve the tool reuse after calibration and supplier calibration capacity in calibration cycle time. Our research is mainly to solve the tool reuse after calibration and supplier calibration capacity in calibration cycle time problems.

The paper is organized as follows. In section 2, the research presents the problem and the notation that is used in this paper. The heuristic construction model describes in Section 3. The case and results illustrates in section 4. Discuss and conclusions are in section 5.

2. Model formulation

This section describes the model and formula. The description of the problem in this study will also be described in detail in this section.

2.1. Problem definition

The problem considers tool planning with tool calibration and order satisfaction. In this case, tool has three characteristics: tool is sharing, one process can use one or more tools, and tool has calibration due date.