Reticle Storage Management in an Automated Semiconductor Manufacturing Facility

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1 Introduction

Due to the increased competitiveness of semiconductor market, semiconductor industries are constantly seeking to improve their manufacturing processes in order to face fierce global competition. The semiconductor manufacturing process is characterized by the increasingly short cycle life, high added value and a high level of product quality. To meet these requirements, the management of manufacturing workshops (called *fab*) is an effective research approach to improve production flows in the manufacturing sector. A fab is divided into different zones (photolithography, etching, diffusion, etc.) where the *wafers* (silicon wafers) pass through to undergo operations. One wafer has different sizes of diameter such as 200mm. Wafers are grouped into packets of up to 25 wafers and form what is known as a *lot*.

In this paper we are interested in the photolithography zone of a real fab. The photolithography operation consists in transferring the schematic of an integrated circuit onto the wafer. To do this, a resin is applied to this wafer. It is then exposed to ultraviolet radiation. During this step, the use of a *mask* or reticle (with a circuit diagram) allows to foment the pattern to reproduce on the wafer. Hence, for this photolithography operation, the right reticle is removed from the stocker. When a reticle is removed, it is placed in a container called POD that protects it from contamination. There are several locations (positions) in the stocker. And depending on the location of the reticle in this one, its removal can be facilitated in terms of remove time. Thus, the removal of a reticle can take more or less time. It can be seen that this area is often bottleneck due to the way reticles are positioned in the stocker. It is therefore important to determine the internal stocker location of the reticle according to the capacity of the stocker, the operations to be performed to maintain a good throughput and have a good performance indicator, etc.

This paper addresses a problem of the automated reticles storage management in an existing photolithography workshop of a 200mm wafer manufacturing facility. The lots and reticles are transported by an Overhead Hoist Transport (OHT, vehicle moving on rails installed on the ceiling) based Automated Material Handling System (AMHS): the challenge is to determine the internal location of each reticle in the stockers, to manage them for process operations.

2 Problem description

The considered photolithography zone has more than 4000 reticles stored in three different automated stockers, called RSM (RSM01, RSM02, RSM03), dispatched in three different areas. In FIG.1, the employed reticles stocker is represented. Each stocker is provided with 2 automated ports, where reticles are stored and retrieved by OHT vehicles. As already introduced, the reticle handling time under the stocker (enter and remove) depends on the reticles storage location inside the stocker: POD Shelf (FIG.1, b) is dedicated for storing empty and full pods, consisting of approximately 60 places, of which 20 places are strictly reserved for storing pods with reticles; the time for removing and entering a reticle in this area (that we will call RETPOD area from now on) is about 15 seconds. In the Carousels Reticle shelf (FIG.1, c) , reticles are stored without pods and it consists in more than 1000 places ; in this case, due to the fact that reticle has to be coupled with the respective pod before exiting the stocker, store and retrieval time is longer and is about 1 minute.

Therefore, the interest is to maximize the number of missions (where with the term "mission" we define the stocker task of storing or retrieving a reticle) in RETPOD location compared to the missions in the carousels so to optimize reticles stocker management and decrease stocker processing time; in other words, the "good" reticles doing the higher number of missions have to be chosen to be stored in the RETPOD location. Ideally, when a reticle has an important activity over a period, at the moment of entering in the stocker, it will be stored in the RETPOD location, as it is supposed to exit in the near future. It has been remarked that only 8% of missions are coming from the RETPOD location, caused by a poor management of reticles in that zone. A statistical analysis of the fab data gives us that reticles missions are not proportional to reticle activity on a given period. In addition, the considered activity period is too long, and this generates uncertainties, for example, on information related to lot arrivals.

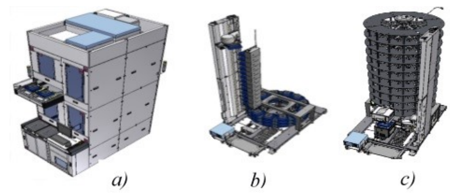

Figure 1: a) External overview; b) POD Fixed Shelf and POD Carousels Shelf; c) Carousels Reticles

In the literature, few studies focus on the reticles storage management: an example can be found in [1], where a comparison between centralized and distributed reticle storage system is presented but no studies are performed on how to optimize the internal management of the stocker.

3 Resolution approach

An algorithm has been developed in order to take dynamically into account the current situation in the photolithography area and to refresh the activity (number of processed wafers) of each reticle in time. With a cyclic refresh time of about 30 minutes corresponding to the time for a reticle to process a lot on a machine, reticles currently outside from the stockers are taken into account and based on the future activity on the next T hours, the internal stocker location (carrousels or RETPOD location) is determined.

4 Conclusion

Experimental tests were carried out on real instances and showed substantial improvement compared to the old approach. We will describe in more detail our method and the results obtained on these instances during the conference.

References

[1] Miller, Murray, "automated reticle handling: a comparison of distributed and centralized reticle storage and transport," 2003