Research on the material transportation automation technology based on SEMI standard

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Keywords: SEMI Standard, semiconductor, material transportation, FA.

Abstract. Using SEMI standards to provide the communication interface and communication information between the semiconductor device and the factory host, in order to improve the yield and quality of semiconductor products has been a general consensus. In this paper, through the analysis of the related standard about the material transport in SEMI, and the specific introduction of the actual device model of the semiconductor equipment, describes the process of material transportation factory automation technology and the application in the actual equipment.

Introduction

With the development of semiconductor manufacturing technology, the material transport in semiconductor equipment has gradual development from the traditional manual operation to factory automation. Semiconductor equipment manufacturers’ demand for factory automation technology is gradually increasing. However, in the face of the complex and large material transport system, how to make the product between each module compatibility and cohesion has become an urgent problem to be solved. SEMI provides an international standard, which can make a semiconductor compatible and closed in the production process. SEMI standard provides the base and guarantee for the factory automation.

SEMI international standards

SEMI standard ensure the wafer in each module between the equipment and equipment accurate, fast, efficient delivery. Among them, E32 process the communications needs about the material transport of semiconductor manufacturing equipments, Mainly used for coordination between semiconductor device, or between the different elements of wafer transfer management. E84 define the parallel input/output control signal between the manufacturing equipment and automated material handling system, which makes the carrier more reliable and efficiency In the process of transmission. E87 is mainly used to verify cassette identification, map wafer, and manage cassette buffer space and other functions. E90 defines the concept, behavior and service information of the wafer information management, it provides the tracking function in the whole wafer processing, and it is used for locating the wafer's current position and process information. E99 defines a universal cassette identification read-write specification, which can improve the interactivity of carrier ID reader, to make the users and the equipment suppliers have a wider choice [1, 2].

Module design of material transportation system

System structure design

Material transport factory automation technology mainly realizes the communication between the host and the wafer processing equipment, its system model frame structure as shown in Fig.1.

Design of the system is divided into three layers, for scheduling layer, module layer and driver layer. Scheduling layer is CTC (Cluster Tool Controller) module, it realize the management of PMC, TMC software module, scheduling and integration function, Including the processing task scheduling, recipe management, data tracking, alarm management and other function modules.
Fig. 1 System module structure

The module layer is divided into TMC (Transfer Module Controller) module, PMC (Process Module Controller) module, and EFEM (Equipment Front-End Module) module. TMC module is the transmission control module. Through the means of wafer identification and carrier slot matching, it realizes the management of the carrier transport process, execution and dynamic adjustment. PMC module is process control module. It accepts the instruction process formula of CTC module, and machining operations on wafer. EFEM module is the front-end module. It through the robot brings the wafer from FOUP to TM cavity. It has the calibration, cooling, handling and other functions.

Drive layer is responsible for timing the call driver to read and write to the underlying data, return the underlying data to the device, in order to maintain the upper software can get and access the data of the latest [3, 4].

**Design FA software structure**

FA software through the communication between semiconductor equipment and factory system, realize wafer transport between the various equipment or inside equipment, in the factory area. Its main structure is shown in figure 2:

![Diagram](image)

**Fig. 2 The internal structure of FA software**

When ECS (equipment control system) sends device events to FA, LinkECS accepts the events, connection software provides the function, accepts the LinkECS events, translates the events to the message format that HOST can distinguish through the function provided by underlying database, and sends to HOST.
The function of the main form module is to open the database service and to handle HOST messages.

After the underlying database service start and connect with HOST, the underlying database will receive the messages from HOST, take an internal treatment, and report the results to ECS.

**Process of material transportation communication**

The process of material transportation communication is shown as Fig. 3.

After the cassette loading wafers is sent to device location, and is confirmed the interlock condition, wafers are sent to EFEM at first, EFEM reports to CTC the wafer ID and the corresponding process information, CTC sends the messages to HOST, and sends instructions according to the situation, or HOST sends transfer instruction directly. In this process, E84 provides the continuous, synchronous transfer between manufacturing equipment and AMHS, as well as the enhanced
specification of error detection capability input/output in the transmission interface. E87, factory delivery system management, provides a standardized behavior for host view communication with production equipment during the coordination, execution, and completion of automated and manual carrier transfers to and from the equipment and, if it exists, its internal butter space.

When TM receives the wafer from EFEM, it sends TM a message to CTC, requests to transfer wafer. CTC will send this message to HOST, issue instructions according to the situation. PM chamber will process wafers with the recipe that CTC specified after the wafers reach to the PM chamber.

After process finished, TM receives the wafers, sends a message to CTC, requests to transfer wafer. CTC will send this message to HOST, issue instructions according to the situation, or HOST sends transfer instruction directly.

EFEM sends a message to CTC and updates the information after the wafer finally back to EFEM. CTC will report the message to HOST. E90 realizes tracking function, defines the concept, behavior, and service information of wafer information management, positions the current position of the wafer, and processing information in the whole process.

Conclusion

With the development of semiconductor industry, factory automation will play a more and more important role in the semiconductor industry in the future. In practical application, different understanding of SEMI standards often lead to the difference of the software, how to understand and use SEMI standard correctly will become an important research topic in the semiconductor industry. This paper presents SEMI material transport model of semiconductor integrated circuit production, analyses the basic process of material transportation and SEMI standard it follows, in factory automation. The model has been used in practical equipment, the normal operation of equipment proves the reliability of this method, and it is helpful for further research of semiconductor control system.

Acknowledgments

This paper is supported by the key laboratory of Chinese Academy of Sciences: Lab. Of Networked Control Systems, as well as, the national science and technology major project (multi manipulator dispatch control and the network control technology between equipment and factory automation system, project number: 2012ZX02102-002), thanks for them.

References


