RFID Application on Manufacturing Process Control in Semiconductor Industry

Yeh-Cheng Chen, R. S. Chen, C.P. Ye and H.M. Sun

***Abstract*—The RFID information system that integrated into semiconductor industry including inventory management, location control and handcar localization. This research focused on cassette management in semiconductor industry. The management enters the data warehouse management from a semiconductor company to the semiconductor company. Based on RFID technology, label information where located on each cassette will be passed to the backend database system. Through RFID technology information, this system presents the RFID label information for the user to achieve tracing purpose. The result unified the RFID and the semiconductor system to establish a set of immediate information management system. Through the RFID technology and flows integration, the RFID system reduced the data warehouse working-hour and increased efficiency in wip production line. The enterprise saved the manpower cost and information transmission was more transparent between customers, manufacture and suppliers.**

***Index Terms*—RFID; process control; inventory management.**

I. INTRODUCTION

In the semiconductor industry usually take large size to achieve economy of scale. To meet diverse customer demands and process large order volume in a timely manner, firms need to optimize the facility layout to accommodate a large number of machine installations, shop-floor personnel, and material storages. However, the limited space within a manufacturing facility is always insufficient to catch up with growing material storage demand and new machine installations.

the semiconductor manufacture job involves multiple processes, the variety and volume of materials needed are quite large. Therefore, the frequent movement of materials by engineers and operators in the aforementioned shop floor facility layout scheme often results in material loss. However, most of lost materials are not really disappeared. They often are just misplaced somewhere in the facility. As a consequence, either engineers or operators must spend extra time and effort recouping those materials beside their normal operational procedures.

The problem plaguing the efficiency of testing process is that some of the testing procedures still rely on manual operations. These penalty costs raise testing firms' operating costs and bring down their profit as a result.

The goal of research is to develop a real-time information system based on RFID technology to achieve the objectives of zero-delay and zero inventory for a semiconductor firms. With real-time shop floor information, the firm can accelerate its shop floor automation process, monitor its production status in real time, and improve its process yields. On the other hand, the RFID-based real-time information system can also enable the firm better share its work-in-process information with upstream suppliers and downstream customers. This information sharing mechanism, enabled by RFID technology, and reduce procurement costs but also enhance the overall supply chain efficiency of semiconductor testing industry. This study explored how RFID technology can help improve shop floor automation of a factory.

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II. LITERATURE REVIEW

A. Radio frequency identification

Radio Frequency Identification (RFID) is a remote storing and retrieving data using devices called RFID tags [1]. An RFID tag is a small object, such as an adhesive sticker, that can be attached to or incorporated into a product. RFID tags contain antennas to enable them to receive and respond to radio-frequency queries from an RFID transceiver [2].

RFID reader is a device that is used to interrogate an RFID tag. The reader has an antenna that emits radio waves; the tag responds by sending back its data [3, 7, 8, 9]. A number of factors can affect the distance at which a tag can be read. The frequency used for identification, the antenna gain, the orientation and polarization of the reader antenna and the transponder antenna, as well as the placement of the tag on the object all have impacts on RFID reader's successful reading rates [4].

An RFID system consists of hardware, including RFID tags, readers, and software [5, 6] .The RFID middleware has to work with conventional middleware.

III. CASE STUDY

A. Semiconductor company

The case study is a large manufacturer of semiconductor products. The company is a leading independent provider providing total semiconductor testing and packaging solutions to fabless companies, integrated device manufacturers and foundries. The goal of the company are to provide advance manufacture techniques, product quality, and good service to its customers. Especially, the company use information technology to construct various information systems including ERP, KM, MES, SCM and CRM

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B. RFID system architecture

This study developed an information system integrating process monitoring, and warehouse location management. The system was implemented in wafer sorting division in company. The RFID system architecture is shown in Fig. 1. This system included RFID Tags, RFID Readers, RFID middleware, and database.

IV. Location Management For The Cassette

Operators need to know whether the cassette or probe card is still in the nitrogen counters or not anytime in order to take full advantage of the current cassette location. The design of the RFID process flow for the cassette in the nitrogen counters is shown in Fig.2.

Step 1. The RFID reader will repeat to read the RFID tags affixed on the cassette and then send label information to the RFID middleware through the RFID antenna.

Step 2. The RFID middleware will write label information into the RFID database automatically.

Step3. The RFID middleware will transmit tag information to location control management system through pre-defined mechanism and start to proceed to data checking.

Step 4. Operators will be able to inquiry cassette location anytime.

V. Design RFID Process Flow

Semiconductor manufacturing company will affix a built-in encoding RFID tag on cassette and transmit electronic work order and shipping notice when they ship goods at the same time. The RFID reader and the RFID antenna will automatically detect the RFID tag and check the information based on shipping notice when the cassette pass though RFID gate. The system will automatically notify semiconductor manufacturing company when receiving the goods. All the process flow is shown in Fig. 3 and described below.

Step 1. Shipment in semiconductor manufacturing company: RFID middleware will leverage Simple Object Access Protocol (SOAP) to transmit lot number, part number, wafer quantity, wafer ID and shipping notice, which belong to this RFID tag, to ERP system in semiconductor testing company when cassettes pass though RFID gate in the semiconductor manufacturing company.

Step 2. Semiconductor packing company: RFID middleware will leverage SOAP to transmit lot number, part number, wafer quantity, wafer ID and shipping notice, which belong to this RFID tag, to ERP system in semiconductor testing company when cassettes pass though RFID gate in the semiconductor testing company.

Next, we will discuss detail process flow when semiconductor testing company received wafer from semiconductor manufacturing company.

VI. Benefit Analysis

The benefit can be divided into two assessments after implementing RFID system in the semiconductor testing company. The two assessments are the warehouse and the wafer-testing area. During this stage, the benefit is the largest wafer testing areas and the location management including customers' cassettes, probe cards, and key parts. It can be expected to significantly reduce the time and improve test equipment utilization in term of lowering test cost and increasing test profits.

1) Reduce shipment time

・The semiconductor testing company implementing the RFID system can reduce 60% of the time after RFID system was implemented.

2) Reduced time for materials waiting

・The semiconductor testing company can reduce 93.3% of the time after the RFID system was implemented.

3) Reduced anthropogenic record time

・The semiconductor testing company can reduce 66.67% of the time after the RFID system was implemented.

In addition, the comparison between the integration architecture of the RFID system platform and the traditional operation mode is shown in Table 1. Its management functions, such as dispatching management, stocktaking, on-site patrol, reporting back, and information analysis, can provide better operating efficiency and information utilization for the case company.

Table 1. Comparison of Business Processes Between Two Different Strategies

Items	**Primary operation**	**Our proposed platform**
Dispatching management	Allocation by administrator	Automatic guide by electronic system
Inventory check	Handled by human and barcode	More efficiency; Retrieve with RFID
On-site patrol	Passive mode	Mobile support with interactive mode
Reporting back	Off line	On line
Information analysis	Batch mode	Real-time display by the system

VII. Conclusion

The benefit after the RFID system was implemented in the semiconductor company. One is to improve efficiency, reduce human error, and eliminate manual processes. The other is enterprise process automation. The results of this study are summarized below.

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1) To set up the RFID monitoring information system. It improves the test processes of the semiconductor through using RFID technology.

2) Electronic work orders directly transmit to the system without any manual operations. Warehouse keeper daily deliveries for the average operating time cut by about 50%.

3) RFID system reduces waiting time and increases its manufacturing quality. The result shows that the production line of the machine could reduce the average time of 90%.

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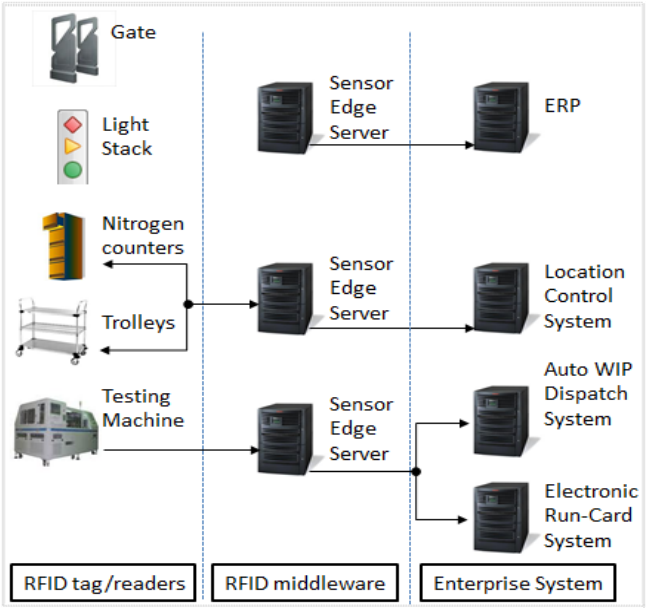

Figure 1 RFID system architecture

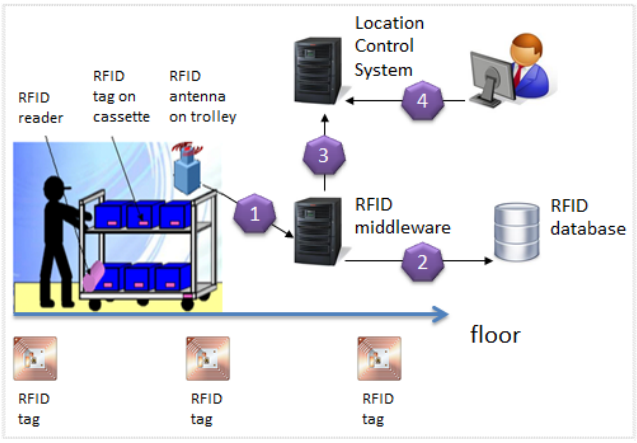

Fig.2 Location management for the handcar

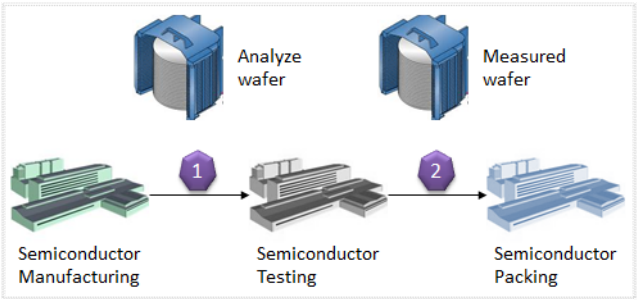

Fig. 3 RFID logistic in the semiconductor supply chain

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