APPLICATION NOTE

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Recording Quality Data in a Semiconductor Manufacturing Process

Industry: Semiconductors
Product: Data Acquisition (DX, MW)

Overview

In order to achieve uniform quality and raise reliability in the manufacture of electronic components such as semiconductors and ceramic capacitors, temperature management and temperature testing are important concerns in quality control. In each of the semiconductor manufacturing processes, data acquisition instruments are used for a variety of tasks.

Customer Needs

- A highly reliable recorder capable of 24-hour, 365-day continuous monitoring and recording
- To save quality data digitally while decreasing the operating costs associated with chart recorders such as replacing spare parts and maintenance. By switching to a paperless system, customers also hope to help the environment and reduce dust in the clean room.
- To centrally monitor quality data from chambers spread over a wide area by combining the data on a network.
- To share quality data between the manufacturing, quality assurance, and development departments.

Process Outline

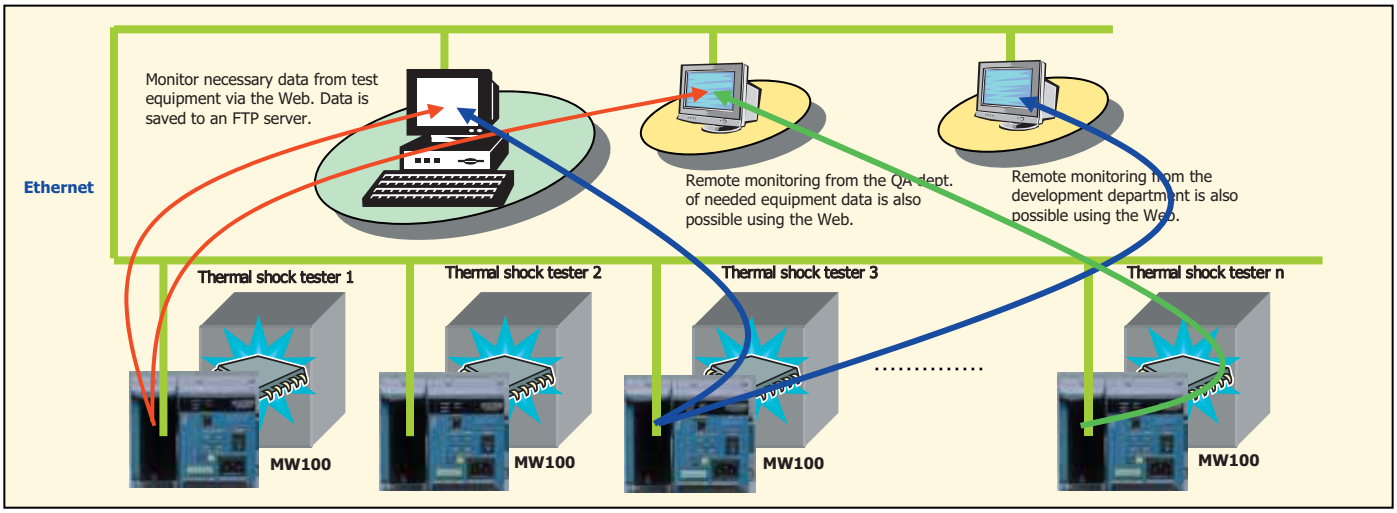
Semiconductor manufacturing processes can be divided into broad categories including silicon wafer manufacturing, creating mask patterns, wafer processing, assembly, and testing including reliability testing. Wafer processing, also called “pre-processing” is the core semiconductor manufacturing process centering on lithography (a photographic prepress operation to form a pattern) and involves repeated stages of washing, heat treatment (oxidation), impurity infusion, film forming, and other steps.

The post-processing phase begins after processing of the wafer and includes assembly and subsequent steps. During this phase the chip is embedded in the package (assembly) and subjected to reliability and other kinds of testing.

As these steps involve a variety of processes including monitoring of temperature during heat treatment in thermal diffusion furnaces and monitoring of burn-in and other reliability tests, they require many recorders and data acquisition instruments. These instruments are also widely used for monitoring of ion currents during ion implantation, monitoring of cleaning solution and water levels in the washing process, and monitoring of temperature, humidity, and static electricity in clean rooms.

1. Reliability Evaluation Testing

Environmental tests are performed on the packaged device during reliability testing after assembly to initially weed out product with inferior reliability. But in order to reduce reliability testing times, thermal shock (a temperature cycle) is applied to the devices for accelerated testing. In order to test large quantities of multiple types of product, dozens of thermal shock chambers are run together in parallel. By using the DAQMASTER MW100 for this task, you can put together a low-cost, simple system for centralized and remote monitoring as shown in figure 1 below.



YOKOGAWA

1) The MW100 has a minimum configuration of 4 or 10 channels, and modules can be installed to increase that number. Compact, low cost, few-channel models can be installed at each chamber (high-distributed) and integrated by Ethernet to create a system with reduced wiring.
2) The MW100 functions as a standalone data logger. Testing and quality data from each of the chambers is saved on local media (CompactFlash) installed in the MW100s, eliminating the risk of data loss due to communication problems.
3) Using the MW100's Web Server function allows real time monitoring of measured data via the network. Monitoring can be performed via the Web using Internet Explorer and other browsers, and no additional software need be installed.
4) Using the MW100's FTP function, test results saved to local memory can be transferred to an FTP server upon conclusion of each test. Test results from each chamber can be combined into a quality record for centralized management on a single server.
5) The Viewer software that comes with the MW100 includes a data conversion function. When creating quality reports, this function allows you to work with data on Excel and other commercially available spreadsheet programs.
6) The MW100 offers contact output of alarm information and notification by e-mail. It also supports unattended continuous testing.
7) If you wish to monitor the current test status locally on a display at each of the chambers, you can use the DX100/DX200 Paperless Recorder. If you use DAQExplorer software for the DX100/DX200, data files sent by the DX's FTP function can be automatically converted into Excel format thereby reducing data processing labor.

2. Temperature Control in Thermal Diffusion Furnaces

In diffusion furnaces--widely used in the impurity infusion process-- atoms of the impurities are supplied in gaseous form, thermally diffused, and the pn layer is formed. If temperature is unevenly distributed the thermal diffusion will not be uniform and quality will be compromised. Therefore, temperature distribution inside the diffusion furnace is a critical element of quality control data. Just as in the thermal shock test chambers mentioned above, this application also allows you to use the MW100 or DX100/DX200's networking functions to widely distribute the data acquisition instruments and simultaneously save wiring.

3. Monitoring the Clean Room Environment

The environment of the clean room itself affects the quality of the manufactured product. Uniform temperature and humidity are maintained, and the room must be constantly monitored so that static electricity does not exceed a predetermined value. As paper-based chart recorders naturally cannot be used in clean rooms, the MW100 and DX paperless type recorders are ideal. All of these models feature Web server functions allowing remote monitoring of the conditions inside the clean room.

4. Controlling Levels of Washing Water

Washing is part of many semiconductor manufacturing processes such as lithography, impurity infusion, and film forming, and a large amount of cleaning fluid and purified water is used. The amount of purified water can be monitored for water savings without affecting quality, and alarms can be output if the flow drops suddenly to unacceptable levels.

5. Data acquisition in the thin-film formation process

Thin film formation is a process of forming (depositing) dielectric films, silicon films, and metal films on a substrate. This involves steps including sputtering and chemical vapor deposition (CVD). Sputtering is a technique whereby a quantity of aluminum is bombarded with ions to strip off aluminum atoms and deposit these onto a wafer. The aluminum atoms are activated by an ion current, therefore product quality can be controlled primarily by monitoring the amount of this ion current. And since this process is carried out inside a vacuum chamber, the degree of vacuum can be concurrently monitored and recorded.
CVD is a technique in which a particular gas is supplied to the surface of the wafer to cause a chemical reaction that generates a layer of molecules which are deposited on the wafer. Heat and plasma energy are employed to catalyze the chemical reaction. The main parameters being tested in this process are the amount of supplied gas and the temperature inside the equipment. Recently, rapid thermal processors have begun to be used in this process to rapidly raise temperature through lamp irradiation, and in this case, the MX100/MW100 is suited for data acquisition every 10 msec.

Yokogawa's Solution

The MW100: Few-channel, high-distributed, networked data logger

- Offers two data acquisition formats, a PC-free standalone logger and a PC based data acquisition system. Local memory of up to 2 GB (CompactFlash card)
- Modular architecture allows flexible construction of data acquisition systems from 4 or 10 channels to hundreds of channels.
- Highly dispersed units are integrated over the network (Ethernet comes standard)
- Allows simple sharing of data with other platforms through support for a variety of networking functions including Web, FTP, e-mail, and MODBUS/TCP.
- High speed sampling (10 msec on the 4 ch high speed module)

Conclusion

By using the network compatible MW100 or DX series instruments for quality records of the various processes in semiconductor manufacturing, you can simply and inexpensively create systems giving you a high-distributed, wiring-saving data acquisition environment, with network-enabled data integration and sharing of data with other departments.