

e-diagnostics Technology for Supporting e-manufacturing

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OVERVIEW: In order to support the volume production of advanced semiconductor devices in the 90-nm node, in addition to rapid startup, confirmation, and repairs of equipment at the device manufacturer's site, e-diagnostics is required to provide a broad range of support services, including preventative maintenance and process support. Specific results that can be expected are: (1) reduction in MTTR (mean time to repair), (2) increased operation rate, and (3) reduction in maintenance management costs.

INTRODUCTION

IN recent years, improving the OEE (overall equipment effectiveness) of semiconductor manufacturing equipment has become a major issue for device manufacturers and equipment vendors, who are actively promoting efforts to introduce e-manufacturing, driven by ITs (information

technologies). These efforts are not limited to conventional production management using a MES (manufacturing execution system). Development of EES (equipment engineering system) is being promoted with a focus on various types of equipment information contained in the equipment itself. There has been a particular increase in activities targeting

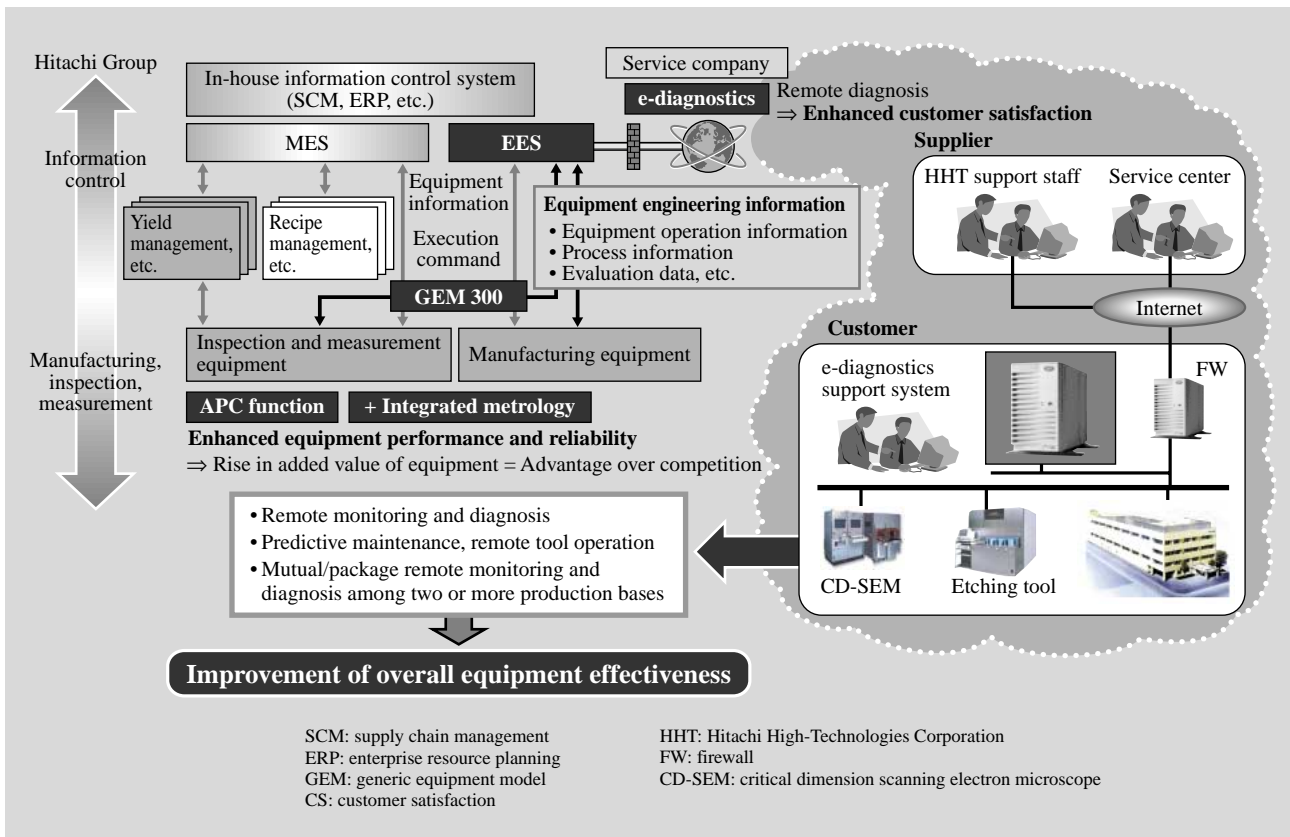


Fig. 1—e-diagnostics Technologies in the Context of e-manufacturing Business. As part of the e-manufacturing concept proposed by the Hitachi Group, e-diagnostics (a remote diagnostics technology) enables reductions in MTTR (mean time to repair), improved equipment operation rates, and significant reductions in maintenance management costs for customers.

the construction of advanced intelligent systems, which are designed to carry out corrections in finishing accuracy within and between processes using APC (advanced process control), and to execute accurate operation and maintenance of individual devices using FDC (fault detection and classification) and e-diagnostics.

As a reflection of the importance of compatibility and commonality of specifications in the context of methods for transmitting the above types of equipment information, there has been much activity related to the amendment and publication of guidelines, based on standardization activities led mainly by SEMI* (Semiconductor Equipment and Materials International), ISMT (International SEMATECH: Semiconductor Manufacturing Technology), JEITA (Japan Electronics and Information Technology Industries Association), and Selete (Semiconductor Leading Edge Technologies, Inc.).

Hitachi High-Technologies Corporation has developed a new e-diagnostics system targeting the company's own plasma etching equipment products. Here, we will discuss e-diagnostics, one of the technologies for supporting e-manufacturing (see Fig. 1).

THE NEED FOR E-DIAGNOSTICS

Outline of e-diagnostics

e-diagnostics is a technology for accessing production equipment at the device manufacturer's production base via networks to carry out remote diagnostics, thus achieving reductions in maintenance management costs, as well as failure prediction and prevention. In recent years, semiconductor production bases have been expanding and shifting to a variety of regions, both in Japan and overseas. Providing sufficient follow-up services even under these conditions has become an increasingly important issue for equipment vendors.

We believe that this can be achieved if equipment experts at service centers or sales offices can use the Internet, a fast and inexpensive communication infrastructure to conduct diagnostics and analyses of on-site equipment.

e-diagnostics Guidelines

e-diagnostics guidelines were proposed by ISMT in 2000. Formulation and amendment of these

* SEMI is a trademark or registered trademark of Semiconductor Equipment and Materials International in the United States and other countries.

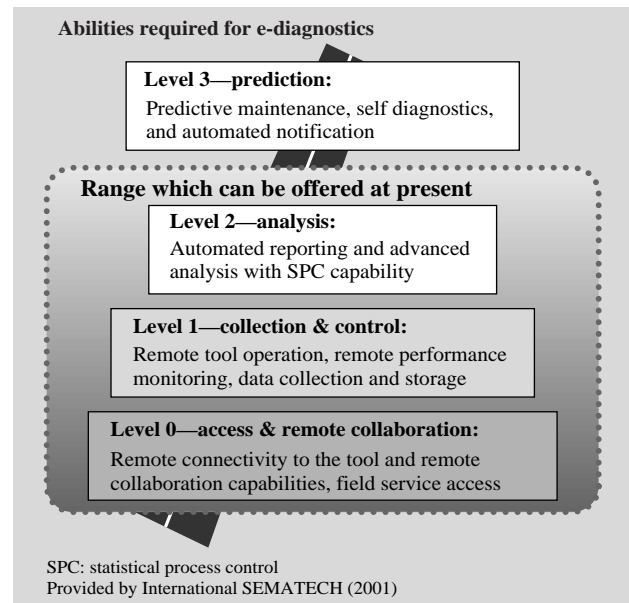


Fig. 2—e-diagnostics Guideline.

e-diagnostics guidelines advocated by ISMT are divided in four levels.

guidelines is currently ongoing, incorporating the opinions of device manufacturers and equipment vendors. In preparation for final implementation, the guidelines have been divided into four stages, as illustrated in Fig. 2.

OUTLINE OF E-DIAGNOSTICS SUPPORT SYSTEM

Toward the Implementation of e-diagnostics

When executing remote diagnostics using e-diagnostics systems, the following points must be taken into consideration.

The security of data must be assured, due to concerns regarding negative effects on production processes and leaks of confidential production data as a threat to the device manufacturers.

The systems must be in line with SEMI standards and guidelines advocated by ISMT.

The systems must be able to coexist with the device manufacturers' firewalls and other existing network systems.

Hitachi High-Technologies Corporation now conducts sales and service within Japan, adopting systems produced by America's Axeda Systems Inc., which satisfy all of the above requirements, and is promoting developments in this area.

Features of e-diagnostics Support System

The following are the main features of the

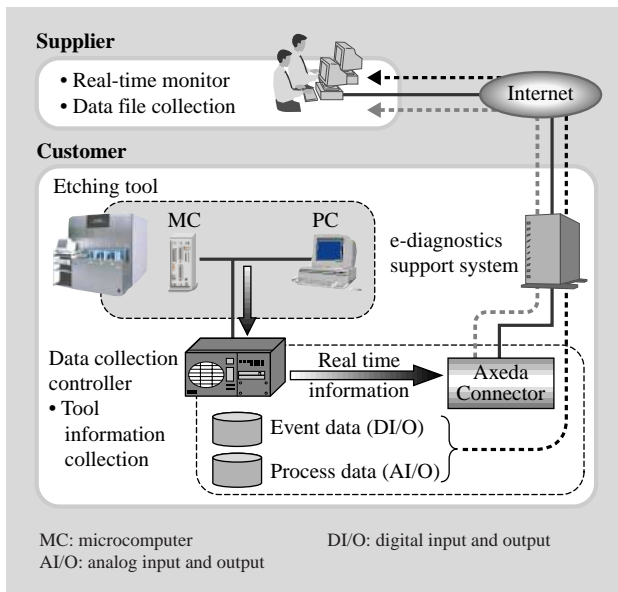


Fig. 3—Outline of Data Collection Controller.

The data collection controller acquires and stores equipment information from the etching equipment, and sends information required for status monitoring to the e-diagnostics support system in real time.

e-diagnostics support system.

All information is protected using advanced security functions including login authentication and authentic functions at various stages, as well as encryption using Blowfish (a 32- to 448-bit variable-length encryption key technology).

Firewall-friendly technology enables applications in an environment protected by high-level security without the need for construction of special networks, assuming an Internet-ready environment.

Various functions required for e-diagnostics can be achieved by preparing a built-in software Axeda Connector*¹ in advance. These functions include: Internet communications, real-time data acquisition, user authentication, mutual security between databases (incorporates Oracle*² instance functions), remote management, and e-mail notification.

System Configuration

We have developed and installed a data collection controller, which acts as the interface between the e-diagnostics support system and the equipment, to facilitate real-time acquisition and storage of various types of equipment information. By incorporating the Axeda Connector in the above configuration, it becomes possible to achieve remote diagnostics of plasma etching equipment (see Fig. 3).

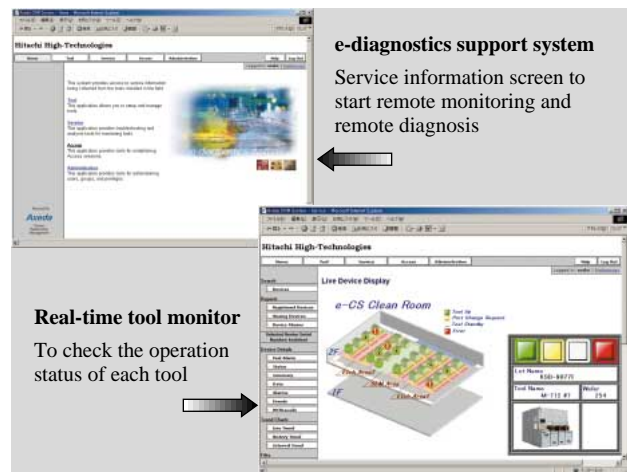


Fig. 4—e-diagnostics Support System.

Service screen after login authentication, the user is able to confirm a wide range of information, from overall operating status of the clean room to status of the equipment itself.

The data collection controller acquires and stores various types of equipment information (2,500 items) at 500 ms intervals. Information required for remote monitoring is transmitted in real time via the Axeda Connector.

The user accesses the remote diagnostics function through login authentication. At this point, the user is able to check the items covered by the remote diagnostics, i.e. the overall status of the clean room and the operating status of the equipment (normal operations, standby while awaiting wafers, abnormalities, etc.) via the Web browser (see Fig. 4).

The system's Axeda Access*³ functions are effective in checking detailed equipment status, as well as for operation and maintenance support. These functions facilitate sharing or operation of equipment screens in remote locations, and also enable downloading of equipment information files from remote locations using file forwarding functions. In addition, the equipment information obtained in this fashion can be used to carry out failure analyses.

The system offers dramatic effects in terms of both cost and security by enabling authorizations for operations based on two-way authentication, which eliminates the need for a special global IP (Internet Protocol) address at the connection destination location.

*1 Axeda Connector is a trademark of Axeda Systems Inc.

*2 Oracle is a registered trademark of Oracle Corporation.

*3 Axeda Access is a trademark of Axeda Systems Inc.

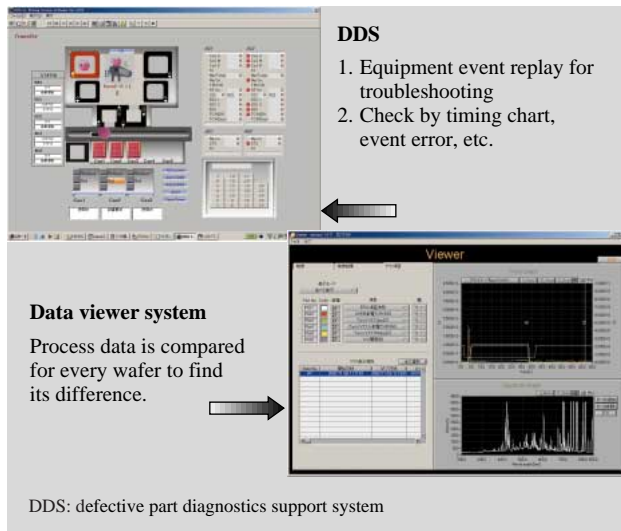


Fig. 5—Analysis and Diagnostics Applications.
Screen images of applying analysis and diagnostics application software are shown.

Status of Response to Guidelines

From the perspective of equipment vendors, the ultimate goal of e-diagnostics is the prediction of failures. If situations can be grasped before equipment abnormalities occur, allowing for measures to be taken in advance, this would contribute significantly to improved OEE.

This system has achieved the second level of the ISMT guidelines mentioned above, utilizing a separate system for audio and video collaboration. In the future, we will continue to accumulate technologies for the analysis of various types of equipment information and knowledge regarding diagnostics, thus achieving the final level of these guidelines' preventative maintenance.

ANALYSIS AND DIAGNOSTICS APPLICATIONS

There are two main types of equipment information that can be acquired via the Internet using Axeda Access functions: equipment operation log files that display DI/O information, and AI/O information such as gas flow and pressure. We have developed the following application software to execute analysis and diagnostics using this information (see Fig. 5).

DDS Equipment Failure Diagnostics System

DDS, an equipment failure diagnostics system with a GUI (graphical user interface) that enables easy-to-understand operations on the diagnostics side, is designed to allow quick and accurate failure analysis.

Using the operation log file, equipment operations

before and after a failure can be recreated, making it possible to confirm conditions in the processing room, history of operations by equipment type, position of wafers, and other information using easy-to-view graphics.

This system enables displays of operation events and error lists, as well as timing chart displays based on AI/O and DI/O information.

Data Viewer System

The data viewer was intended especially for use as a process analysis tool. Etching process information during the actual process is stored as AI/O information, and the user can then create displays or conduct analyses and data comparisons for each wafer using graphs based on this data.

Analysis, Diagnostics, and Their Effects

Here, we will explain specific analyses and diagnostics assuming implementation of the above system by a device manufacturer, as well as the effects of these analyses and diagnostics.

An e-diagnostics support system installed by or shared by a device manufacturer regularly accumulates equipment information, such that both the device manufacturer and the device vendor can confirm current operation status via Microsoft Internet Explorer* or another Web browser.

In the event that some type of abnormality occurs in the equipment, the production line equipment manager or the equipment vendor is automatically notified via e-mail. In addition to preventing product failures before they occur, this enables equipment failure countermeasures to be initiated from an early stage, thus reducing the number of failures and shortening MTTR.

Depending on the details and conditions of the failure, the operator can use the Axeda Access functions to gain shared access to equipment screens, making it possible to confirm equipment status or acquire important equipment information stored in the data collection controller from a remote location, and to quickly determine the causes of the failure using DDS, data viewer, or other functions. Furthermore, by statistically analyzing past equipment information and effectively using the results of those analyses, the device manufacturer is able to reduce the cost of equipment maintenance and management, and to

* Microsoft Internet Explorer is a product name of Microsoft Corporation.

provide “peace of mind” as a part of its service menu.

Here, we will offer one further application example from the perspective of protecting information related to advanced development products and other confidential matters. We believe that the introduction and installation of the e-diagnostics system offers significant merits for device manufacturers with multiple production bases inside and outside Japan, as well as for makers with production technology management bases, even if they have not received a request from the equipment vendors for remote diagnostics services.

This is because parties conducting maintenance management and process management for production facilities are able to carry out remote monitoring and diagnostics of equipment, either interactively or all at once, using familiar desktop PCs with Internet connections. This will enable them to achieve significant improvements and savings in work processes that were once complex and time-consuming; for example, in the case of business trips, the process of collecting and analyzing data to determine whether there is a need to dispatch staff directly to individual production base.

CONCLUSIONS

Here, we have discussed the current status and future developments related to e-diagnostics technologies in the context of e-manufacturing, a field that is currently the focus of activities in the Hitachi Group. These technologies will bring about dramatic changes to methods for the provision of follow-up services that in the past were offered by equipment vendors, and, we believe, will rapidly evolve into new service methods and service systems that will transcend the boundaries of space and time.

The Hitachi Group will continue to develop and utilize advanced technologies to further promote the evolution of e-manufacturing, and at the same time will make sweeping contributions to increased productivity for device manufacturers.

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