Design and Development of Open Graphical User Interface Software for IC Equipment

Ni JIN\textsuperscript{1,a,*}, Ai-dong XU\textsuperscript{1,b}, Ming-zhe LIU\textsuperscript{1,c} and Kai WANG\textsuperscript{1,d}

\textsuperscript{1}No. 114 Nanta Street, Shenyang city, China
\textsuperscript{a}jinni@sia.cn, \textsuperscript{b}xad@sia.cn, \textsuperscript{c}lmz@sia.cn, \textsuperscript{d}wangkai@sia.cn

*Corresponding author

Keywords: IC equipment, Control system, Graphical user interface.

Abstract. The control system is considered to be one of the core technologies to develop IC equipment. At present, application programs have to be re-developed to satisfy the requirements of specific process of IC equipment, which slows down the product development process seriously. Therefore, an open Graphical User Interface (GUI) software for IC Equipment was designed and developed in this paper. The modularization programming approach was utilized and the concept of open control system was introduced in course of development. The advantage of Windows programming was exploited to the full. The GUI software developed is easy to modify to satisfy the specific process of IC equipment, which provides an open and modular application layer solution for the control system for IC equipment.

Introduction

Integrated circuit (IC) is the core of the electronic information industry. Manufacturing equipment for IC is the pillar of semiconductor industry [1]. Development of IC equipment control system plays an important role in the development of the semiconductor industry.

At present, with the wafer size being more and more lager, from 1 inch to 8 inches, and then to 12 inches, thus introduces the new equipment and new Technology. The wafer production procedures are getting more and more complicated day by day. Different process flow, procedures and chambers bring difficulty to interaction and production management of upper layer human-machine GUIs. Every time, it needs to develop a new IC equipment control system for the new technology because the old one is unable to meet the needs.

In order to solve the problem, the key technologies such as technology control, material transfer, process scheduling, communication management, optimal control, fault detection and so on have been analyzed in this paper. And then a novel open Graphical User Interface (GUI) software for IC Equipment is designed and developed, which provides an open and modular application layer solution for IC equipment.

Open Control System

It is generally considered that open control system should have the abilities of extensibility, interoperability, portability and configurability. In order to meet the requirement of open, modern software engineering and design patterns methods are adopted in the process of design and development of control system [2]. It uses thought of object-oriented design and formalization approach to realize all kinds of functions of the system through a modular and Hierarchical method. It is as far as possible to reduce the coupling degree among levels and improve the reusability of each module in the system. It ensures that the system has clear and complete functional structure and high reusability.

Design of the GUI Software

GUI software for IC Equipment is designed and developed using the Object-oriented Programming language C# and modular programing method, it draws on the concept of open control system and
fully uses the advantage of Windows programming. The software has a friendly human-computer interaction interface which is convenient for users to operate.

The Frame Structure of GUI

The frame structure of GUI provide a common foundation framework for IC equipment, it could meet the need of control for different kinds of IC equipment. The GUI is modeled in order to implement scalability and polymorphism of software. At the same time, the software becomes easy to modify [3]. In the GUI software, there are three layers of structure, includes GUI system framework layer which provides system platform executable environment and common interface, GUI component layer which provides equipment graphical related controls by controls form and equipment control interface layer which provides access interface of the equipment control system. In addition, equipment control model and auxiliary services are external system service modules. The frame structure of GUI is showed in figure 1.

**GUI System Framework Layer.** The GUI system framework layer provides executable environment and integrated interface of components. It also provides major operation forms by paging mode. The GUI system framework itself also provides system common operation and display of information, such as, user login, equipment major operation, factory automation operation interface and so on.

**GUI Component Layer.** GUI component layer consists of GUI common controls, IC controls and GUI common interface. GUI common controls are not only can be used in IC equipment system but also can be used in other system platform. IC controls is designed and used for IC equipment system. GUI common interface provides the common interface and the based class component of system development.

**Equipment Control Interface Layer.** Equipment control interface layer provides access interface of the equipment control system (ECS), all communication with ECS through the interface.

**External Service Module.** External service module is consisted of equipment control module, GUI configuration storage module and auxiliary service module. Equipment control module provides the device driver. GUI configuration storage module is used for storing the configuration files during the GUI running. Auxiliary service module is used to provide service for GUI running, such as, IO service, log service, recipe service, user service, history service, statistical service and so on.

**Process of GUI Software**

Process of GUI software is showed in figure 2.
Implement of GUI Software for IC Equipment

GUI software is developed adopting modular packaging technology, the main graphic elements are designed in controls form which have reusability. Platform software separates the software system and hardware by the graphic unit and driver layer. The graphic unit can connect to the signal acquisition device and control the device by driver layer.

Graphic element is designed using C# technology. Devices and data in wafer process could build GUI for IC equipment in visual controls form which can achieve animation effects according to the actual situation. Users could use the GUI software just like using the actual IC equipment. The develop method based on C# control technology can achieve controls reuse and codes sharing, it also can improve program efficiency and is good for debugging [4].

GUI Software controls provide standard interface for invoking by upper software system framework, their classification as follows [5,6]:

- Common class, they could be used not only in IC equipment control system platform but also in other system.
- Base class, includes base class control and interface control, which is the communication interface between the controls and hardware.
- Controls class, that are basic elements controls, which don’t rely on other controls.
- Composition class, that is composite elements controls, which are consisted of one or more basic elements controls.

System main form is showed in figure 3, major chambers of IC equipment in the figure are designed in C# control form.

In addition, the platform has custom function, it could draw the man-machine interface for monitoring according to the different process flow and equipment system. It also has function of
system configuration, data acquisition, alarm and fault diagnosis.

Different GUI main forms for different IC equipment are showed in figure 4 and figure 5. Figure 4 shows the PECVD equipment with one processing unit, figure 5 shows the PECVD equipment with three processing unit.

![Fig. 4. The PECVD equipment with one processing unit.](image)

![Fig. 5. The PECVD equipment with one processing unit.](image)

Features and advantages of open GUI software for IC equipment as follow:
1. It uses component development method to increase stability.
2. It could configure the system flexibly according to the demand.
3. It is easy to change the number of chamber and change control process.
4. It is convenient to develop, debug and maintain the software.
5. Using C# program language to develop the software.
6. The open configuration interface based on XML.
7. The software supports the mainstream I/O equipment and is easy to expand and changes itself.

**Summary**

An open Graphical User Interface (GUI) software for IC Equipment is designed and developed using the Object-oriented Programming language C# and modularization programing approach, it draws on the concept of open control system and fully uses the advantage of Windows programming. The GUI software can provide the open and modular application layer solution for control system for IC equipment. It has been successfully used in etching equipment, PECVD, TRACK and other IC equipment, its applicability and correctness has been verified. For the special process, the GUI software can provides better support and guarantee.
Acknowledgment

This work was supported by the Important National Science and Technology Specific Project under contact NO.2012ZX02102-002, the Natural Science Foundation of China under contract 61004068 and Lab. of Networked Control Systems.

References


