A Kind of Multi-disciplinary Simulation and Design Platform for IC Chamber based on Commercial Solver

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Abstract: In this paper, a kind of multi-disciplinary simulation and design platform for wafer manufacturing process with Chamber system is presented. This platform is developed as an in-house program, with different functional component for multi-disciplinary problems, which can drive the commercial FEM solver with code. There are also management function for user, products, and analysis or optimization process templates. This platform can be used for analyzing the multi-disciplinary process inside chamber system, DOE and optimization analysis for wafer manufacturing process, product and analyzing process template management.

1 Background

With the rapid development of manufacturing technology, the IC manufacturing process become a kind of very complex and high-accuracy process, which is composed with many different displinary problems, including fluid and thermal field, electric-magnetic field, and plasma field. Chamber is the main reaction part for wafer manufacturing process, such as PECVD, PVD, LPCVD, and etching[CY01]. There are plenty of factors in multi-field inside the chamber, which can affect the wafer fabricating performance. To improve quality of wafer fabrication, it should be considered in a multi-disciplinary interaction perspective[CY02][WT03].

In this paper, a kind of multi-disciplinary simulation and design platform for wafer manufacturing process with Chamber system is presented. This platform is developed as an in-house program, with different functional component for multi-disciplinary problems, which can drive the commercial FEM solver with code. There are also management function for user, products, and analysis or optimization process templates. This platform can be used for analyzing the multi-disciplinary process inside chamber system(such as thermal-fluid, magnetic, and plasma), DOE and optimization analysis for wafer manufacturing process, product and analyzing process template management[MS04].

2 Platform Introduction

2.1 System Structure

This platform system is composed with three functional group, which are User-Interaction module, Solver and Analysis module, and Data and Process management module.

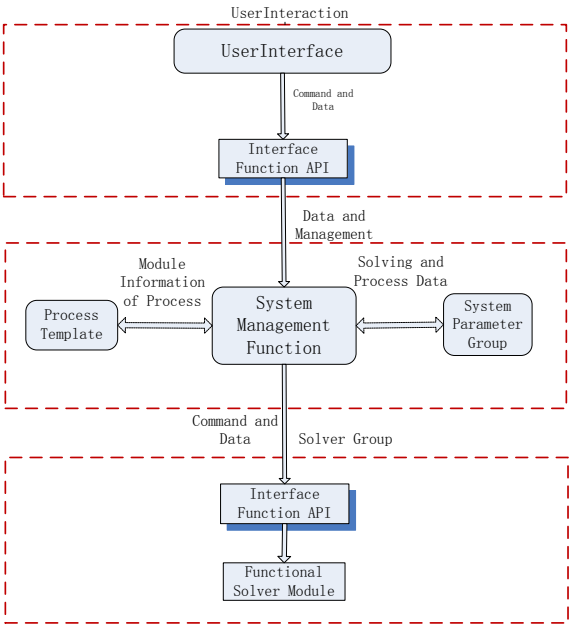

Figure 1: System structure

User-Interaction module is a connection module with user and platform. This module include user-interface and interface function API. The first one is the window for user and platform system, which can be used for receiving data and command from the user, and can provide analyzing results to user. The Interface function API can be used for delivering the data and command in and out between User-interface and platform system.

Data and Management module is the core management part for the system. This module includes system management function, system parameter, product, user database, and analyzing process template database. This part can be used for receiving the data and command from upstream part, store the parameters and products information into database, then deliver the command to downstream part from interface function API.

Solver module is the functional part for this platform system, which can execute simulation, data analyzing, DOE design, and process optimization. This module includes the API code, which can be used to drive the commercial FEM solver software, DOE

module, and optimization code. The different solver can be executed separately in the logic sequence of the analysis process templates to solve the multi-disciplinary problems inside chamber system. Thus the user can define any analysis problem on IC chamber as a solving process template into this platform system, which can be used for the similar problems with different working parameters, or do optimizations process for this issue.

2.2 Database Structure

This platform is not only a kind of simulation and analyzing tool with commercial software, but also a kind of management system for user, product, process template, and parameters. This platform include four group of data tables, which are user table, products table, simulation process template table, and simulation and analyzing parameters table.

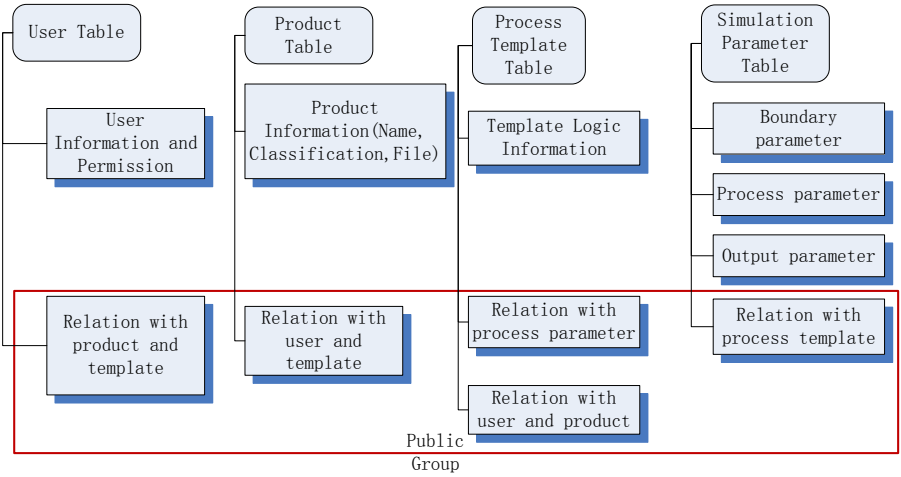

Figure 2: Database structure

User table is used for statistic and management of user data, including user information, permission, and the relation information with products and process templates

Product table is used for statistic and management of product data, which need analysis and optimization. These data include product information (such as name, classification, file), and relation information with user and analyzing process template.

Process template table is used for statistic and management of analyzing process template data, including template logic information, which show the solving sequence of each function component for one process, and relation information with process parameters, user and product.

Simulation parameter table is used for statistic and management of simulation process parameters, including model geometry parameters, simulation boundary parameters,

process control parameters and output parameters. Relation information with process template is also included in this table.

2.3 Working Process

This platform is a kind of process analyzing and data management system, which is based on user group and corresponding products. Each user and product possesses different process analyzing and related parameter records, which are focused on different physical field.

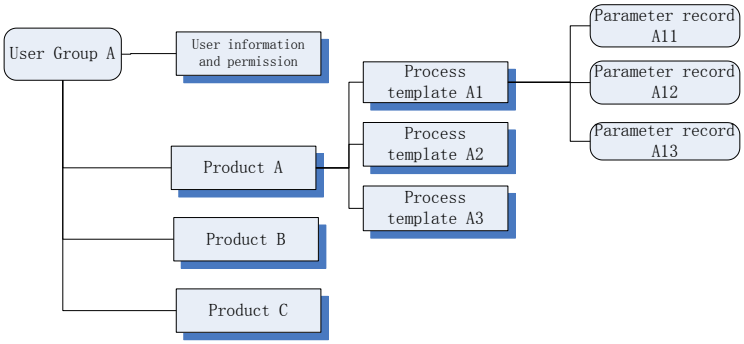

Figure 3:Working Process

Figure 3 shows one sample of working process of this platform.

3. Data Center and System Model

3.1 Experiment Platform for ICP system

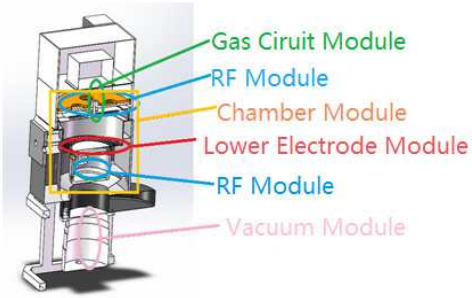

Figure 4: Experiment platform module

To verify the accuracy of simulation results, a experiment platform for ICP system has been building, which can obtain more process data of IC chamber in detail. This platform is combined with five parts, which are gas circuit module, RF module, chamber

module, lower electrode module, and vacuum module. The test data can be obtained from these detecting equipments, including plasma energy parameters, electron parameters and gas composition proportion.

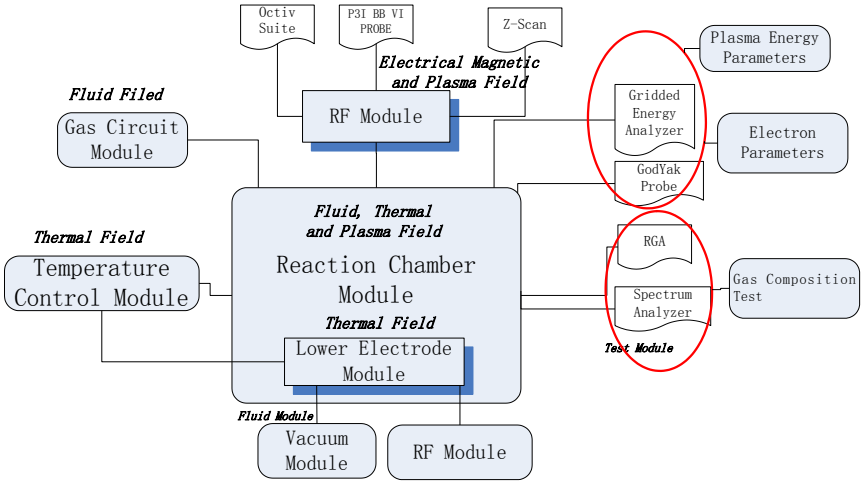

Figure 5: Experiment equipment system

3.2 Simulation Platform for ICP system

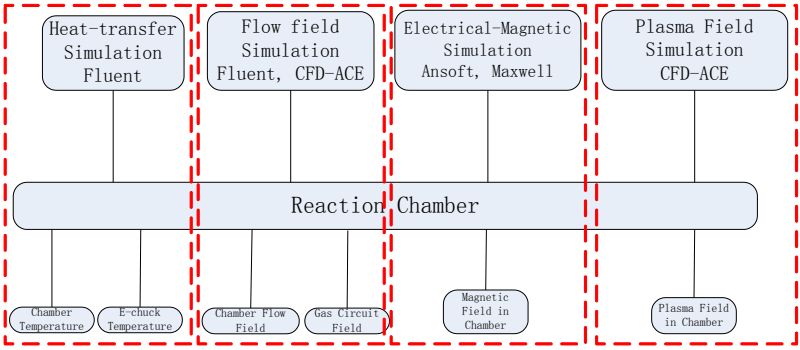

Figure 6: Simulation platform system

On account of limited data acquired from test system, simulation platform system is built to get more detailed results in multi-disciplinary fields. In the simulation system mentioned above, there are four categories of analyzing component for reacting chamber model, which are consisting of heat-transfer, flow field, electrical-magnetic and plasma field with different commercial FEM solvers, such as Fluent, CFD-ACE and Ansys.

With the simulation platform, detailed information of reaction chamber can be obtained, with multiple groups of operating parameters or geometry parameter sets. The results from this system can be used for comparison with data from test system to calibrating

simulation model. Furthermore, the simulation system after calibration with test data can be used to implement DOE process automatically, and create system research model for IC chamber model.

4.Conclusion

In this paper, simulation and experiment platform system has been built for the research on IC reaction chamber model. Both of the two systems can be used for launch multi-disciplinary FEM calculation and tests for chamber system. The calibration process of simulation platform can be implemented with data from experiment system, to improve the first one mentioned of these two systems[RME05].

Furthermore, the improved simulation platform can be used to do more intensive study for IC chamber, such as executing DOE process, optimization and creating system model to describe the relationship with different components inside complex IC chamber.

References

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