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The Characteristics of the Third Generation Multipurpose Plasma Immersion Ion Implantation Equipment

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The third generation multipurpose plasma immersion ion implantation (PIII) equipment was designed, installed and operated recently. It has been successfully used for general R & D applications in metallurgy, tribology, surface modification of materials, and fabrication of novel materials. Compared with the first generation PIII equipment, a number of key techniques were substantially improved in the new equipment. It can produce many kinds of gas and metal plasmas, perform metal plasma ion implantation and deposition, and combine ion implantation with sputtering deposition and coating, etc.. It has much better functions and characteristics than the first generation PIII equipment. This paper describes its construction, functions, and characteristics.

1. Introduction

A multipurpose plasma immersion ion implantation (PIII) facility (Model-1 PIII) have been designed and successfully used for surface modification of materials in our laboratory in 1995.[1] Since that time, some basically physical and technical problems of the PIII have been studied deeply, and some key techniques of the PIII have been substantially improved by means of this equipment. On the basis of these research works, the third generation multipurpose PIII equipment (Model-3 PIII) has been designed, installed and used successfully for general R & D applications in metallurgy, tribology, surface modification of materials, and fabrication of novel materials. The new equipment has much better characteristics and functions than the first generation PIII facility. This paper describes its construction, characteristics, functions, and novel features.

2. Construction and characteristics

2.1 Design principles of the Model-3 PIII equipment

(1) In order to perform metal plasma immersion ion implantation and deposition (MePIIID), the equipment is equipped with intense current pulse cathodic arc metal plasma sources, and a slowly rotating target stage.

(2) In addition to metal plasma sources, there are other four means of production plasmas in the equipment, such as RF plasma source, RF antenna, multifilaments modules, RF/DC sputtering deposition.

(3) High dose rate implantation, MePIIID, mixing implantation of gas and metal ions, combination of ion implantation, coating and sputtering deposition, etc. can be carried out in the system.

(4) The quantity of the accesses of the main vacuum chamber is increased for many kinds of plasma diagnostics and parameters measurement, including temperature measurement, etc..

(5) The main vacuum chamber is big enough to treat samples and industrial components with suitable dimension and achieve batch process.

2.2 Main improved components

(1) Four sets of long range, intense current, pulse cathodic arc metal plasma sources[2] are inserted symmetrically into the wall of the vacuum chamber to perform MePIIID function. Experimental results showed that the maximum mean deposition rate in a circle of 100 mm in diameter at the distance of 250 mm from the exit of the magnetic filter was > 3 Å/s.

(2) Pulse high voltage power supply

Heat diffusion and metal plasma sources are used in the new system, maximum output voltage of the power supply is decreased to 65 kV to reduce its cost, technical difficulties and obtain an optimal implantation voltage waveform.

(3) Multifilaments modules

Eight sets of welding construction multifilaments modules produce high density, uniformity gas plasmas.

(4) 13.56 MHz RF plasma source

Its total power is increased to 4 kW from origi-

nal 2 kW to increase plasma density.

(5) Gas feeding system

Three mass flow meters are used in the new system to obtain differently mixed gas compositions.

3. Functions and applications of the model-3 PIII equipment

Many functions and applications can be performed in the new system, such as MePIID, ion beam enhanced deposition (IBED), and ion beam assisted deposition (IBAD), preparing DLC and multilays construction thin films, low energy elevated temperature PIII,[3] combination of RF plasma nitriding and PIII, combination of ion implantation, sputtering deposition and coating, and other techniques.

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