DEVELOPMENT OF SEMI-MASS PRODUCTION APPARATUS FOR ANTISTATIC IC TRAY WITH LOW ENERGY ION BEAM

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Abstract

For industrial applications, we have developed an ion beam process for a surface modification of an IC Tray using the 50keV high current injector technology of KOMAC(KOrea Multi-purpose Accelerator Complex). To produce an IC Tray with antistatic surfaces, we designed a simple and low price ion beam irradiator without an acceleration column and analyzing magnet. The essential beam subsystems of this machine are the ion source, beam transport column, irradiation chamber, differential pumping system and automatic IC Tray transportation system. This apparatus is at present operating at the current of 50mA and extraction voltage 50kV. We transferred this technology to a venture company.

1. Introduction

Polymers have been increasingly used in various fields of applications because of their unique properties, such as a low density, ability to form intricate shapes, versatile electronic properties and low manufacturing cost. Electrically conductive polymers are very useful in a wide variety of industries[1,2]. Among the uses of these materials are EMI and rf shielding, antistatic surfaces and battery electrodes. In order to enhance the electrical properties of the polymers, ion implantation techniques have been suggested[3-6]. Ion implantation attracts more and more attention as a method to modify surfaces of various materials, including polymers.[7,8]. Until now ion beam technology has been extensively used to study and modify the surface properties of polymeric materials[9-12]. Today, however, its industrial application is growing only slowly despite a vast amount of research and development. In this paper, we will describe briefly the technical features of the ion beam irradiator and semi-mass production apparatus for antistatic IC Tray, which will be used in industry.

2. Ion Beam Irradiator

The simple ion beam irradiator is designed to make an experiment on the surface modification of the IC Tray at low cost, as shown in Fig. 1. To achieve these goals, we adopted a simple system without an acceleration tube and an analysing magnet which selects ion species.

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It consists of an injector of KOMAC, vacuum system, diagnostic system, power supply, beam transport tube, irradiator chamber and target system.

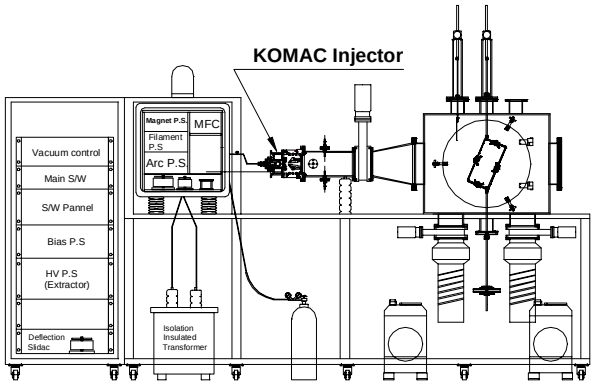

Figure 1. A simple ion beam irradiator for making an experiment on the surface modification of IC Tray.

The detail specifications of this irradiator components are as followings:

Ion Source(injector of KOMAC):
- Thermal cathode : W Filament
- Source Magnet : 10 k Gauss
- Intermediate Electrode : Mild Steel
  Cone Angle of 30 degree
- Distance between Intermediate Electrode and Anode : 2mm
- Anode : Mo, 0.8mm dia, 2.38mm depth

Vacuum System:
- Chamber Dimension : SUS-304,
  800mm ×800mm ×800mm
- Pump : Oil Diffusion, 2000 l/s ×2
- Ultimate Pressure : 4 $\times 10^{-7}$ Torr

Ion Beam Diagnostics:
- Scanning Faraday Cup : 5mm dia., 250 Gauss

Power Supplies:
- Filament P.S. : DC 10V, 50A
- Magnet P.S. : DC 10V, 20A
- Arc P.S. : DC 250V, 15A
- Extraction P.S. : 50kV, 50mA

The simple ion beam irradiator can be utilized for developing various types of ion sources through function tests of ion sources as well as for developing sophisticated surface treatment technologies to be used in mass production of small piece products. This irradiator is designed specially for making an experiment on surface treatment of the IC Tray. This irradiator does not need an additional beam accelerating system; therefore, it can be manufactured at a low price.

3. Semi-mass Production Apparatus

A schematic diagram of the semi-mass production apparatus is shown in Fig.2. A high current ion beam extracted from the ion source is transported to a tray through the column without acceleration. The essential beam subsystems of this apparatus are the ion source, beam transport column, irradiation chamber, differential pumping system, and automatic IC Tray transportation system. The detailed specifications of the apparatus components are as follows:

Ion Source:

- Extraction Voltage : 50kV
- Beam Current : 50mA
- Thermal cathode : W Filaments
- Source Magnet : 250 Gauss
- Intermediate Electrode : Mild Steel, Cone Angle of 30 degree
- Distance between Intermediate Electrode and Anode : 4mm
- Anode : OFHC, 8mm dia, 23mm depth

Vacuum System:

- Ion Source Chamber :
  - Pump : TMP(600 l/s)+RP,
  - Ultimate Pressure : 1 $\times 10^{-6}$ Torr
- Loading & Unloading Chamber :
  - Pump : Booster Pump(1,100 l/m)+RP,
  - Ultimate Pressure : 1 $\times 10^{-4}$ Torr
- Main Chamber :
  - Pump : Oil Diffusion Pump(8,000 l/m)+RP,
  - Ultimate Pressure : 1 $\times 10^{-6}$ Torr

Ion Beam Diagnostics:

-Scanning Faraday Cup : 5mm dia., 250 Gauss

Power Supplies:

- Filament P.S. : DC 30V, 70A
- Magnet P.S. : DC 30V, 60A
- Arc P.S. : DC 200V, 25A
- Extraction P.S. : 50kV, 50mA

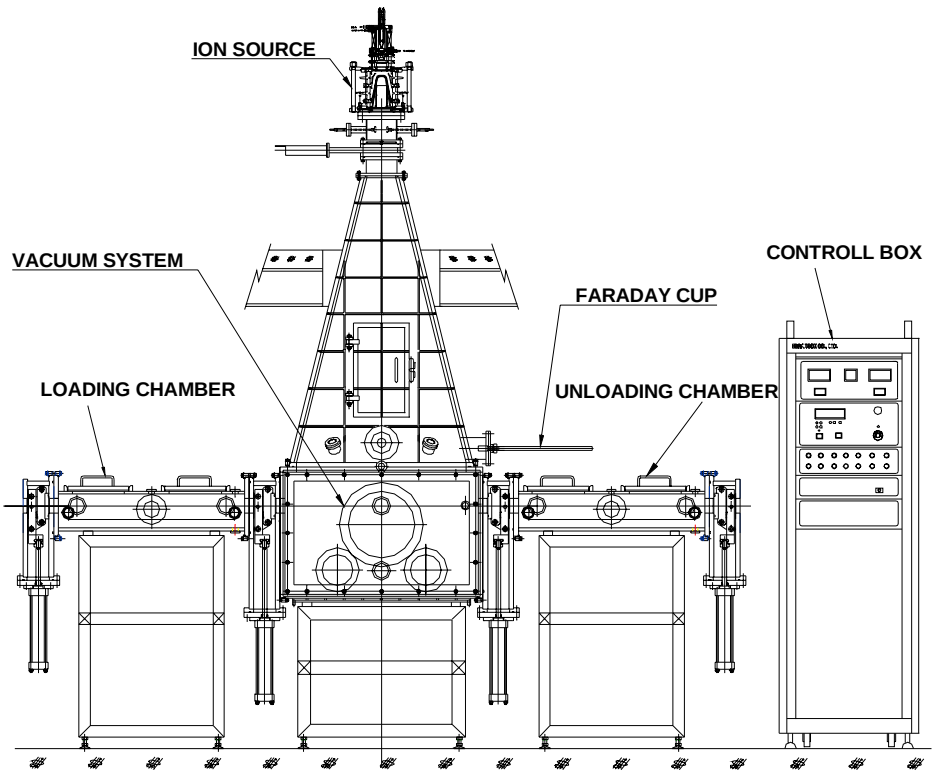

Fig. 2. A schematic diagram of semi-mass production apparatus for the surface modification of IC Tray.

4. Beam Characteristics

For the industrial application, large area surface modification is very important due to the cost problem. Also, the uniformity of the ion beam is very important for the continuous processing. The beam profile is measured by a linear scanning system based on a Faraday cup with a 5mm diameter. The obtained current distribution for the ions extracted from the injector of KOMAC displays the Gaussian distribution as shown in Fig.3. As the ion beam current is increased, the current distribution of the center region is decreased because the plasma sheath shape at extraction grid is changed due to the space charge effect [13]. For the large area ion beam treatment, we developed a simple extraction grid system. The large area profile of the ion source is shown in Fig. 4. The beam profile can be influenced by the multi hole extraction system, but we can get a uniform large area ion beam profile with a two hole system. Each electrode has two holes which are arranged in such a way that a uniform beam is obtained at the end station. The area that can be used to irradiate on the IC Tray is about 30cm in vertical beam profile.

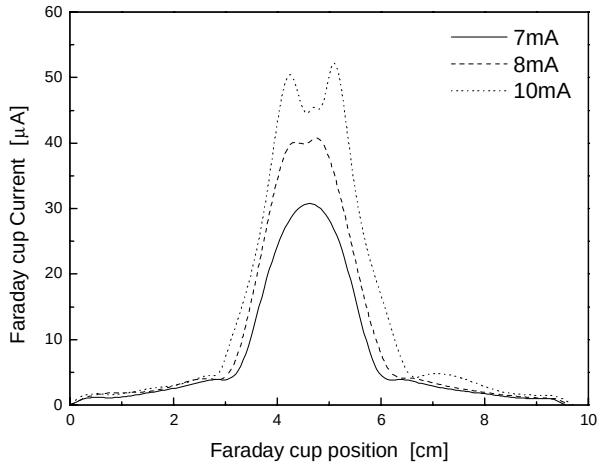

Fig. 3. Ion beam current profile of the injector of KOMAC.

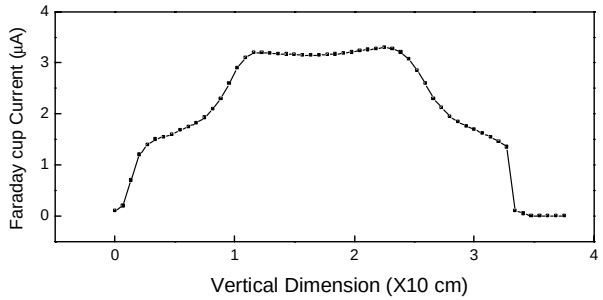

Fig. 4. Vertical beam profile of 50keV, 50mA ion source.

5. Summary

For high throughput operation in ion implantation processes, a high current ion beam and a large area ion source with a uniform beam extraction unit are necessary. To achieve these goals, we developed a simple ion beam irradiator without an acceleration column and analyzing magnet as shown in Fig. 1. And it can be utilized for developing various types of ion sources through function tests of ion source as well as for developing sophisticated surface treatment technologies to be used in mass production of small piece products. As an example, development of a semi-mass production apparatus specially designed for ion beam treatment of an IC Tray can be achieved by using this technology.

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