INTENSE HEAVY ION DUOPLASMATRON SOURCE

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Abstract

The experimental results for the production of intense helium, nitrogen, oxygen ,mixed neon-helium(78%Ne+22%He) and argon DC ion currents have been given by means of the duoplasmatron source. When arc current is 5A, extracting voltage is 20KV, 59mA helium, 48mA nitrogen, 35mA oxygen, 41mA mixed neon-helium, and 22mA argon ion currents have been obtained after the Einzel lens which used as initial focusing system of beam extracted from the duoplasmatron source.

1. Introduction

Before now, we have reported a duoplasmatron source which produced up to 100mA hydrogen ion currents (1)(2). In resent experiment, we have invetigated oprating characteristics of the source for the production of some heavy ions, such as, helium, nitrogen, oxygen, mixed neon-helium and argon ion,etc.

Low-energy(30kev-few hundred kev) and large area ion beam techniques, such as, sputtering, ion implantation, activated reaction, surface construction, collision mix and phase transition,etc.are developed rapidly since the seventies of the century(3)(4). The hyperfine processing, microelectronics technology, advanced development of new device and material modification,etc. called ion engineering, have became one of critical techniques in modern sciences. Only for the ion implantation to investigate materialmodification, the material engineering as an impotant subject of study has rapidly been developed in the world as well. Especially this technologies have been used in respect of space techniques, in which some special materials are used. Meantime, intense heavy ion beam has been used not only in the ion engineering but also in the heavy ion accelerators. Therefore, the study of intense heavy ion source with good quality is a important problem.

Due to the limitation of time the analysis of the mass spectrum and charge state of beam extracted from the duoplasmatron source havn't underway yet. The production of ion currents of some solid elements and the measurement of beam quality will have been completed in next stage experiment.

2. Experimental Installation

The experiments have been made on the experimental facilities of intense beam ion source in Lanzhou University. (code name: LU-IBEF-1). Detailed description of the duoplasmatron source and the experimental installation may see earlier articles (1)(2).

Argon and mixed neon-helium gas with the analytical purity and nitrogen , oxygen and helium gas with the physical purity, which are as working gas of the source, were used in this experiment. Working gas of the source is led into discharge chamber from the bottom of the cathode and the flow of gas is controled by the needle valve. Extracted ion currents from the source are focused by initial focusing system which is made of Einzel lens and the beam currents are measured by means of water-cooled Faraday cup which depart from the exit hole of the source is about 500mm. The ratio of hole diameter to depth of Faraday cup is: 45mm:250mm. The diaphragm with 40mm hole diameter for suppressing secondary electrons is located at the inlet of the cup and the suppressing voltage is minus 350 volt. When the gas consumption of the source is zero, the static vacuum of the measurement chamber is 5×10^{-6} torr. During the beam extracted, the vacuum is range of $(1.2-1.5)\times10^{-5}$ torr.

3. Experimental Results

Extracted characteristics of beam currents from the source for helium, nitrogen, oxygen,mixed neon-helium and argon ion are shown in Fig.1- Fig.2 respectively.

In order to compare of experimental results main working parameters of the source, such as, presure, arc currents, and magnetic field, were elected as follows: the gas consumption was controled by the needle valve so that the presure of discharge chamber of the source was kept up at 1.2×10^{-1}torr in every experiment; The value of arc currents were elected as 3A, 4A,5A, respectively; Exciting currents of the magnetic field of the source were elected as corresponding optimum value. The presure value of the discharge chamber was measured by thermocouple gauge which was located at the bottom of the cathode. The reading of the thermocouple gauge hadn't calibrated for air.

Due to the limited of power of extracting supply maximum value of the extracting voltge was only used in 20kv. When extracting beam currents from the source were over 50mA, owing to the space-charge effect which lead to beam dispersion, part beam currents (about 10% of total beam) strike at the intermediate electrode of Einzel lens and lead to heating of the electrode. According to value of working presure of discharge chamber in every experiment, the gas consumption of the source was measured by U-gas flowmeter respectively. Thus the gas consumption of each kind gas in the condition of the experiment are respectively: He (64.5ml.atm/hr), N (36.7 ml.atm/hr), O (33.5 ml.atm/hr), mixed Ne-He (31.8 ml.atm/hr), and Ar (20.5 ml.atm/hr).

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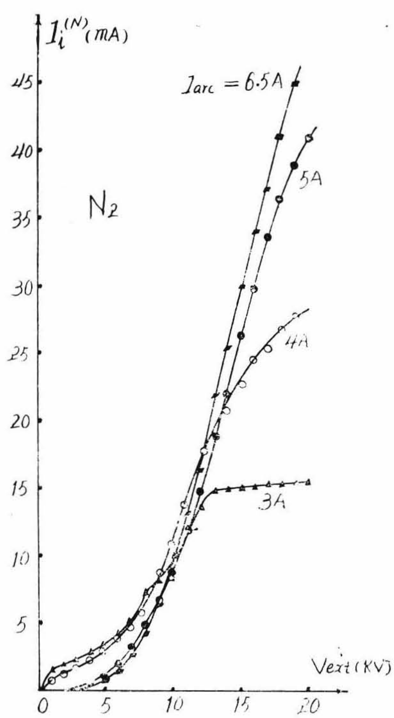

Fig. 1. Extraction characteristics of N ion currents from the source.

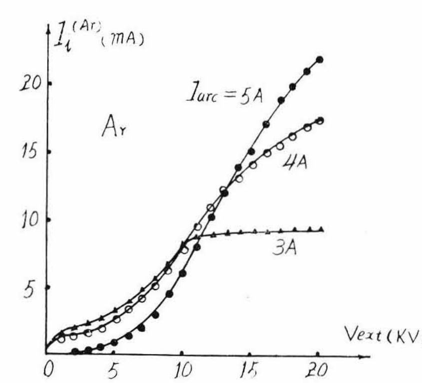

Fig. 2. Extraction characteristics of Ar ion currents from the source.

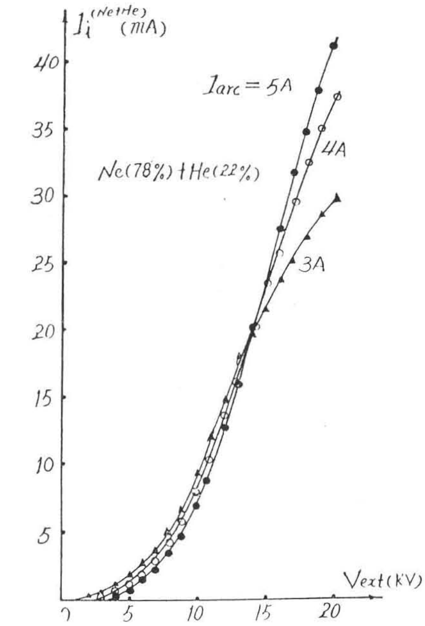

Fig. 3. Extraction characteristics of Ne+He ion currents from the source.

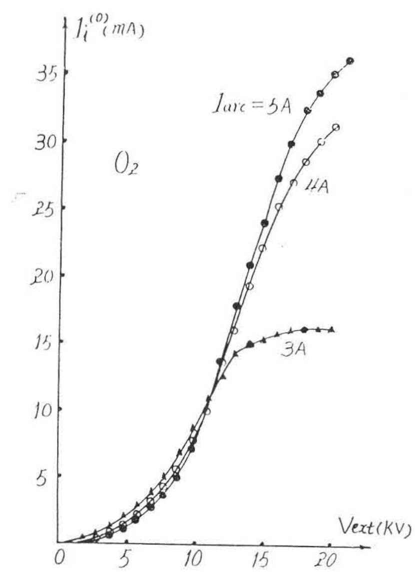

Fig. 4. Extraction characteristics of O ion currents from the source.

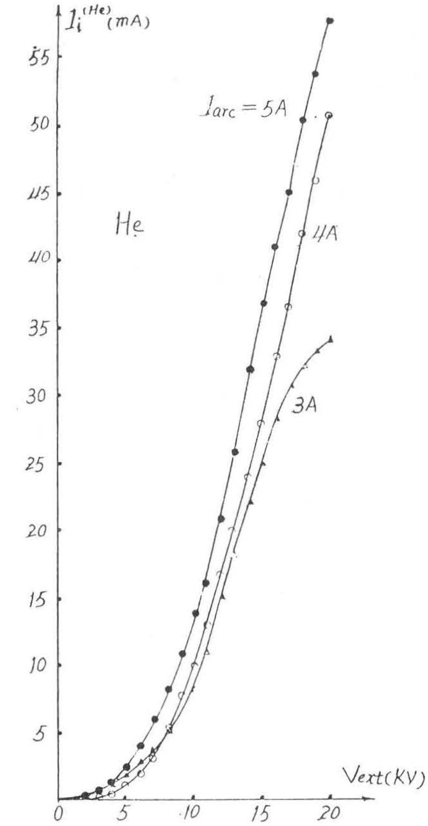

Fig. 5. Extraction characteristics of He ion currents from the source.

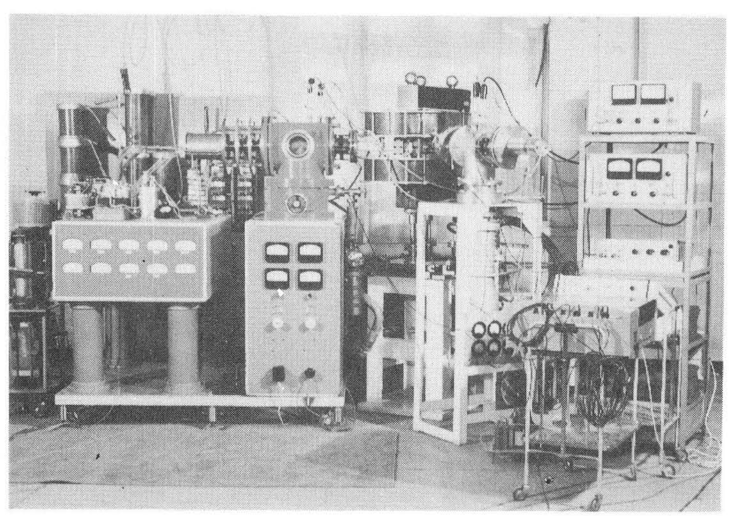

Fig. 6. Photo of LU-IBEF-1.