Cu^{+} ions extraction of the modified Bernas ion source

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1. Introduction

Gas ion implanter using Duopigatron ion sources has been used to improve surface properties of the material at PEFP(Proton Engineering Frontier Project). Gas ion implanter is limited to ion species such as feeding gases. Bernas ion source[1][2][3] with heating elements is adopted to use heavy ions like metals. This paper is presented about feasibility of the Cu+ ions extraction from the ion source.

2. Modified Bernas Ion Source

The layout and picture of the Bernas ion source with indirectly heated cathode is shown in Fig. 1. Left side of the picture is a part of connectors isolated by an insulator. A right part of the picture is the ion source. The ion source consists of heating elements, discharge chamber, and extraction system.

Heating elements can supply feeding neutrals with evaporation to seeded chloride powders. Heating elements which is made of stainless steel covers a cylinder case, called crucible, with the powders. Heating elements can heat crucible around 600^{o}C.

Discharge chamber has some electrode to sustain plasma. Using indirectly heated cathode which is made of tungsten the lifetime of the ions source can be enlarged. The electrons emitted by the filament and accelerated around 0.7kV heat the tungsten cathode. To improving the confinement and generation of the plasma transverse magnetic field was induces. The magnetic field was 0.4 T. To provide the injection of the electron beam from the filament into the discharge area, the tungsten cathode was contacted to discharge chamber. The anticathode exists opposite direction. The anticathode plays a role with reflectors also which can reduce electrons loss.

Extraction system has 3 electrodes which can extract 20 keV positive ions. Suppression electrode was used to reduce back streaming electrons which is biased negatively around -2kV. Whole system of the power supplies of the ion source can see the Fig 2.

To pick up desirable ions we chose a dipole magnet for 90 degree bending. This magnets can supports fields to separate heavy metal ions up to silver with the beam energy of the 20keV.

Whole system of the ion source including the dipole magnet exists on high voltage terminal as shown in Fig. 3.

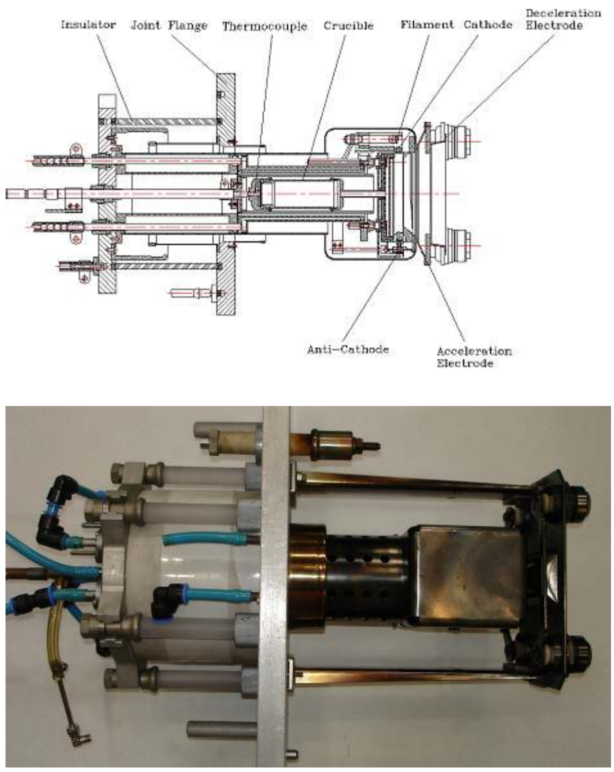

Fig. 1. Schematic diagram and picture of the ion source

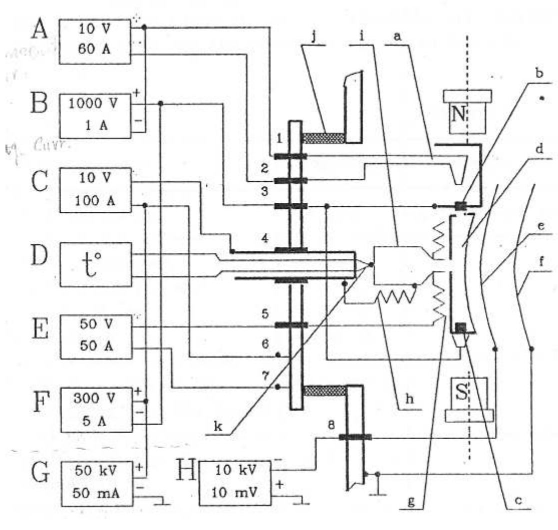

Fig. 2. Schematic circuit diagram of the ion source. Components;
a) Filament, b) Emissive cathode,
c) Anti cathode, d) Discharge chamber,
e) Intermediate electrode, f) Ground electrode,
g) Discharge chamber heater, h) Crucible, i) Insulator

Power supplies;
A) Filament power supply, B) Cathode Heating power supply,
C) Crucible heating power supply, D) Thermocouple,
E) Discharge chamber heating power supply,
F) Arc Discharge power supply, G) Extraction power supply,
H) Bias power supply

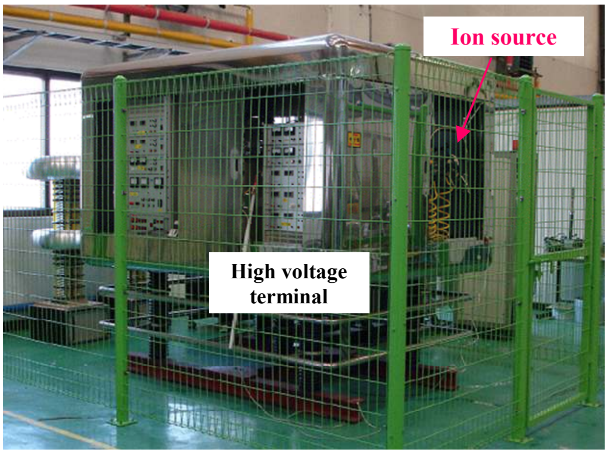

Fig. 3. Picture of the ion implanter with Bernas ion source

3. Cu^+ ion extraction

We chose a copper chloride with relatively low melting temperature to check feasibility of the ion source. Stable plasma can sustain under the 400 °C and can be extracted at this plasma condition. Extracted copper ion can be identified using the method of the auger electron spectroscopy (AES) as shown in Fig. 4 Concentration analysis of the AES is used with samples of the Cu+ irradiated Al target. Atomic concentration of the copper ion is dominant in Fig. 4

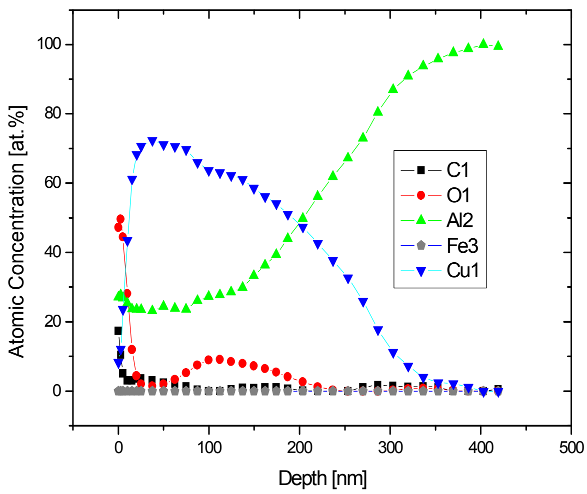

Fig. 4. Atomic concentration of ion species as a function of measured depth of the implanted Al target using AES

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