Chlorine, Iron, and Gold Ion Beam Extraction with 1.7 MV Tandem Accelerator at KOMAC

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Abstract

The 1.7 MV pelletron-type tandem accelerator (NEC 5SDH-2) has been operating at KOMAC (Korea Multi-purpose Accelerator Complex), Gyeongju. The low energy beam implantation service is currently operating for user and Ion beam analysis service, PIXE and RBS will be start. The 1.7 MV tandem accelerator can accelerate a variety of ion for use in PIXE, Implantation, RBS and nuclear physics experiments. Negative ion beams produced in a negative ion source are a little accelerated to 30 keV before being injected into the tank(5SDH-2). The negative ions are taken to the positively charged high voltage terminal and they are stripped of two or more electrons and converted into positive ions in stripping system. Positive ions are repelled by the voltage terminal and ions are accelerated once again. The method of applying high voltage up to 1.7 MV in KOMAC uses the principle of van de Graaff accelerator. However , KOMAC tandem accelerator is pelletron-type. It is more efficient than the original type because it can charge in double. By using a bending magnet, you can select the isotopes from the ion source. In the same way, you can select the multiply charged ions that you want to extract after acceleration. A device with this ability can extract a variety of ion beams. It can also be used in various fields by utilizing various ion beams. For example, ion beam analysis technology, destructive physical analysis, etc. So, we will introduce how we extracted, accelerated, and implanted the three elements(chlorine, iron, gold) that are highly useful.

System Description and Methods

Fig. 1 Overall view of 1.7 MV Tandem accelerator

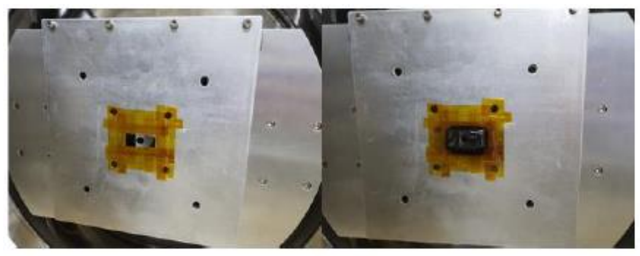

Fig. 3 Photos before and after iron beam implantation on silicon plates.

- **Characteristic**

- **Manufacturer : NEC**
- **Acceleration Voltage : 0.1 ~ 1.7 MV**
- **Max. Energy : 3.4 MeV for proton**
- **Ions : Proton, D, He, Cl, Fe, Al, etc.**
- **Voltage Stability : < 1 kV**
- **Beam Current : 10 μA max.**
- **Type : Tandem**
- **Insulation : SF6 gas**
- **HV charging method : pelletron chain, 2 sets**
- **Charging current : 300 μA**
- **Voltage ripple : < 500 V**

$$F = \frac{\gamma m v^2}{\rho} = \mathrm{qv}\beta \rightarrow \beta\rho = \frac{mv}{q} \rightarrow \beta\rho = \frac{\sqrt{2Em}}{q} \quad (1)$$

$$amu = \frac{\frac{m}{q}\times 1.6\times 10^{-19}}{1.67\times 10^{-27}} \quad (2)$$

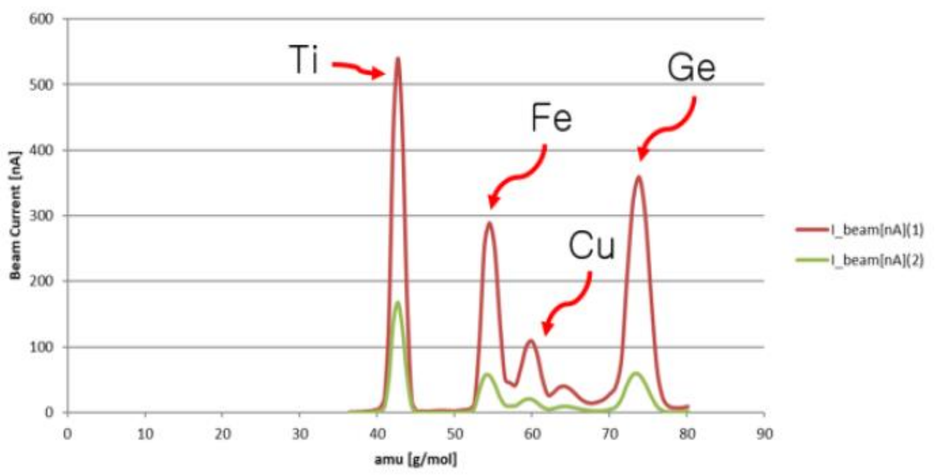

Fig. 2 Iron cathode mass spectrum scanning by changing the value of the current applied to the bending magnet

Results

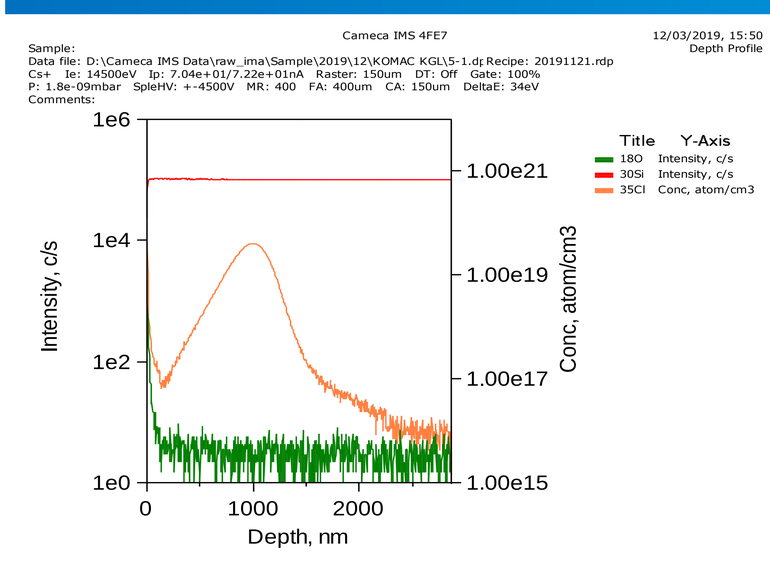

Fig. 4 Result of D-SIMS analysis (1 MeV Chlorine)

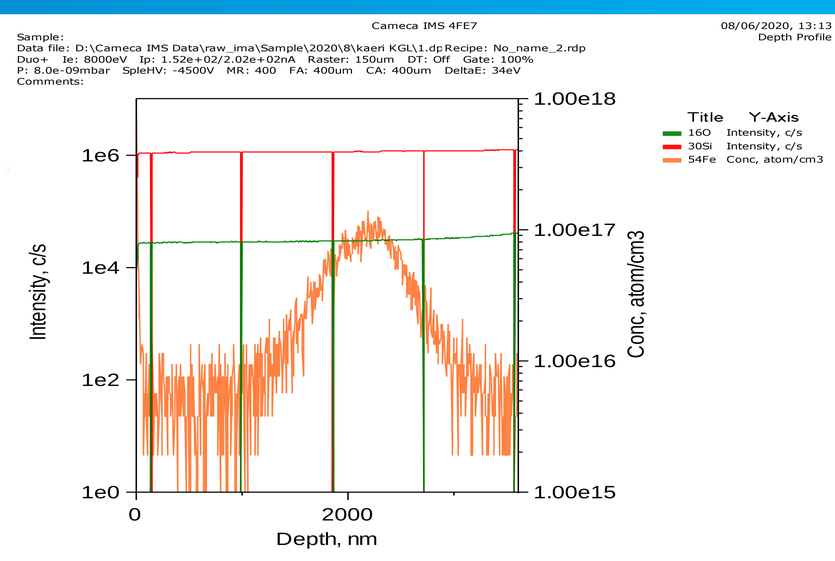

Fig. 5 Result of D-SIMS analysis (3 MeV Iron)

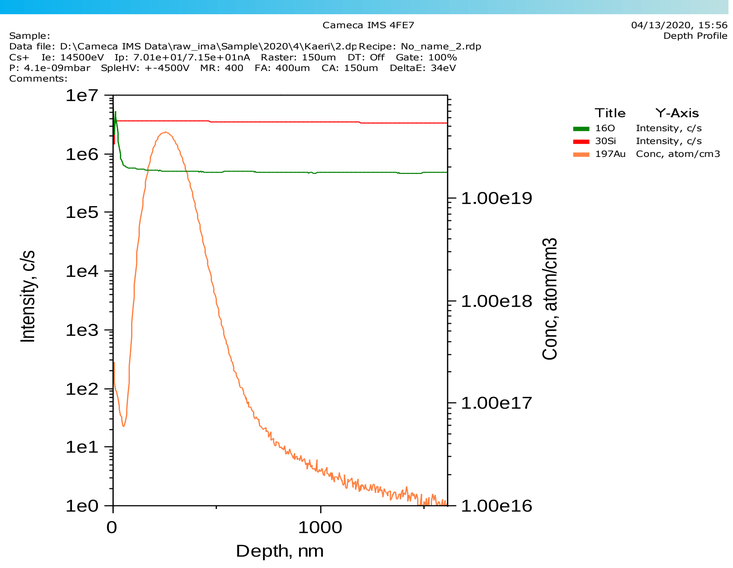

Fig. 6 Result of D-SIMS analysis (0.8 MeV gold)

Element	Cl^{+}
Energy (MeV)	1
Dose (#/cm²)	1E+16
Source Magnet (A)	12.2
Bending Magnet(A)	80.4
Beam current(μA)	1.43

Element	Fe^{2+}
Energy (MeV)	3
Dose (#/cm²)	1.07E+16
Source Magnet (A)	16.2
Bending Magnet(A)	86.9
Beam current(μA)	0.26

Element	Au^{2+}
Energy (MeV)	0.8
Dose (#/cm²)	2.85E+15
Source Magnet (A)	30.2
Bending Magnet(A)	84.8
Beam current(μA)	0.52

Summary

This experiment was conducted because of the demands of users who want to use various ion beams. Although it succeeded in extracting various ion beams, there were many things to improve. For example, a bending magnet should be upgraded to extract higher mass ion beam with higher energy or it is necessary to try another ion beam extraction based on this experiment. In the future, we will improve this device more useful and reliable.

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