

A HOT CATHODE PIG HEAVY ION SOURCE FOR THE IPCR CYCLOTRON AND LINAC

I. Kohno, A. Shimamura, T. Tonuma, H. Nakajima, T. Kageyama and S. Kohara

The Institute of Physical and Chemical Research

In the IPCR Cyclotron some multiply-charged heavy ions : C^{4+} and N^{4+} have been accelerated using a hot cathode IPG ion source, since 1968.¹⁾ At present, more kinds of heavy ions : B^{3+} , C^{4+} , N^{4+} , N^{5+} , O^{5+} and Ne^{6+} can be accelerated by pulsed operation of the source. And we are promoting to develop a similar PIG source for the new IPCR linac. In this paper we report the constitution and operating conditions of the hot cathode PIG source, and production of multiply-charged ions.

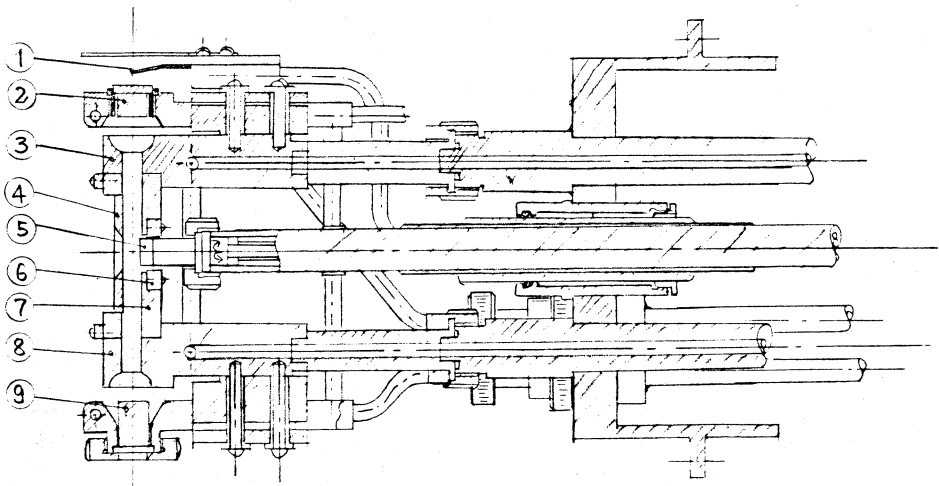


Fig.1 Cross-sectional view of the hot cathode PIG source with a sputtering electrode. 1) Filament 2) Cathode 3),8) Cold anode(Cu) 4) Slit 5) Sputtering electrode 6) Insulator 7) Anode(SUS) 9) Anti cathode

Fig.1 is a cross-sectional view of the PIG source which is of the electron bombarded hot cathode type similar to Morozov's.²⁾ Fig.2 shows the block diagram of the pulsed arc power supply which is composed of a power switching circuit and the DC power supply used, also for the CW operation. In this source intensities of multiply-charged ions are increased when gas pressure in the arc chamber is decreased and an arc power supplied is increased.

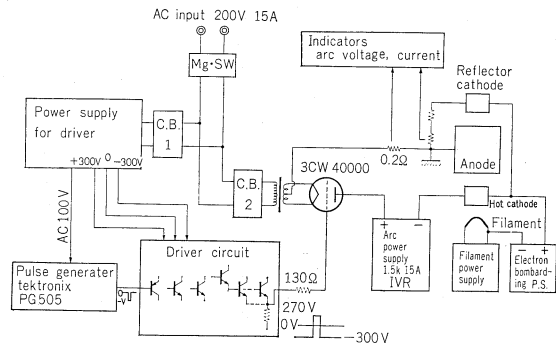


Fig.2 The block diagram of the arc power supply.

These dependencies on the gas pressure and the arc power are shown in Figs.3 and 4. From the experimental results, to obtain multiply charged ions with higher charge states : N^{5+} , O^{5+} and Ne^{6+} the pulsed operation is very effective, because at the peak of pulse a higher arc power can be supplied compared with CW operation. Typically, the source was operated with an arc potential drop of about 500 V and an arc current of 8 to 12 A at peak. A duty cycle of about 30 % and a pulse duration of about 1 msec were chosen as shown in Fig.5. Table I indicate intensities of several multiply charged ions extracted from the cyclotron and energy ranges at which several ions can be accelerated in the IPCR cyclotron.

On the other hand, to develop the PIG ion source for the linac we have assembled the test facility. In the test facility we have tried to produce a several multiply-charged metal ions mainly. Fig.1 shows a hot cathode PIG ion source with a sputtering electrode. The sputtering electrode is made of a metal of which ions are produced in the arc chamber, and on this electrode about 500 V negative to the arc chamber was supplied. Typically, the source was operated with an arc power of 400 V and 3 A by feeding Ar gas at first. After the arc discharge became stable, an electrical potential of about 500 V was supplied to the sputtering electrode, and a current of 30 to 100 mA flowed to the sputtering electrode. In this source multiply charged ions of Fe and Cu metals were produced, and the Cu sputtering electrode was eroded by sputtering with about 1 g in 7 hours.

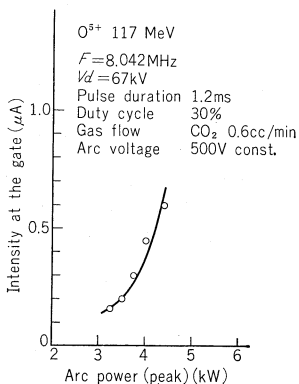


Fig.3 A variation of yield of O^{5+} ion versus the arc power.

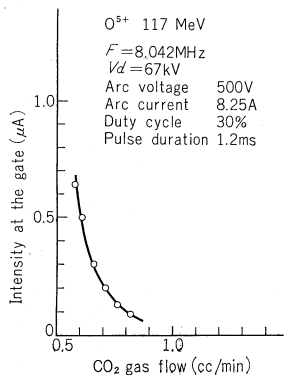


Fig.4 A variation of yield of O^{5+} ion versus the gas flow.

- Reference 1) Y. Miyazawa et al : IEEE Trans. Nucl. Sci 19 No.2 105(1972)
2) P.M. Morozov et al : Atomnaya Energiya 2, 272(1957)

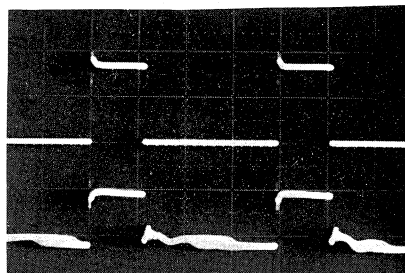


Fig.5 A typical wave form of arc discharge. Current(upper) in 5 A/div. Voltage(lower) in 500 V/div. Horizontal is 1 ms/div.

Table I

Projectile	$^{12}C^{4+}$	$^{14}N^{4+}$	$^{14}N^{5+}$	$^{16}O^{5+}$	$^{20}Ne^{6+}$
Energy(MeV)	60~100	65~100	60~125	65~125	82~160
Extracted beam current(µA)	10	10	10*	10*	0.5*

* pulsed operation