THE DIFFERENCE BETWEEN THE METAL ION EXTRACTED FROM THE R.F ION SOURCE BY APPLYING PLASMA CHEMISTRY REACTION AND BY NON - PLASMA RANGE CHEMISTRY REACTION

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Abstract

The paper introduced the difference between using plasma chemistry reaction draw metal ion and non-plasma range chemistry reaction in the r.f ion source. By using of the plasma chemistry reaction draw metal ion higher percentage than non-plasma range chemistry reaction in the r.f ion source. We apply plasma chemistry reaction to r.f ion source and implanter suceessfully. The effect is very well, it has its own characteristic.

1. Forewold

The work of the past were report[1][2]. This paper is main recount work in recent time. The difference between the metal ion extracted from the r.f ion source by applying plasma chemistry reaction and by non-plasma range chemical reaction. The fact of experiment shows that the plasma chemistry reaction drawing metal ion effect well than the non-plasma range chemical reaction in r.f ion source.

The application of the plasma chemistry reaction and sputter in r.f ion source. much number of metal ion beam have been obtained, especially, the problem of drawing higher volatilization temperature metal ion are solved.

2. The compare of the structure feature and experimental result

2.1 Fig.1 is a structure that are engaged to plasma chemistry reaction.

1-1 is the desired metal of producing ion, it is put into in plasma in discharge chamber, after the halogen family element into discharge chamber and the gas is ionized by the coil of the r.f oscillator, the plasma of the halogen family element is produced. It quickly take place chemically react with metal, the plasma containing both halogen ions and metal ions are further formed. Then by the drawing system of the source and the magnet analyser metal ion beam and other needed is obtained. Graph is shown in Fig.2 and Fig.3 are the ion mass spectrum of Be and Pd.

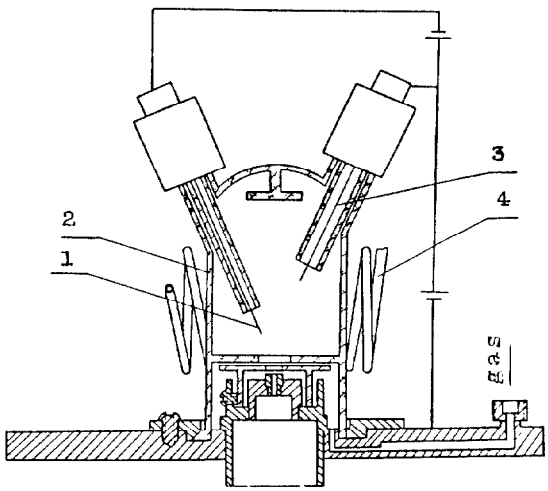

Fig.1 The structure of the r.f ion source by the use of plasma chemistry reaction.
(1) The metal of producing require ion; (2) The discharge chamber make of quartz glass; (3) The anode; (4) The coil of the r.f oscillator.

2.2 Fig.4 is a structure of the r.f ion source by non-plasma range chemical reaction. 4-1 is the desired metal of producing ion, it is put in a quartz tube which internal diameter is ϕ3-4mm, the quartz tube is put into plasma with metal together, However,

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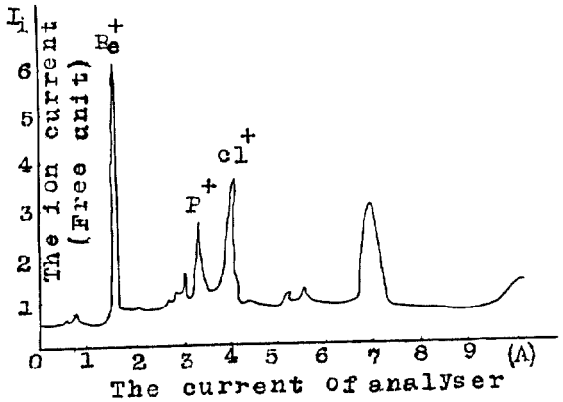

Fig.2 The ion mass spectrum of Be + PCl_3

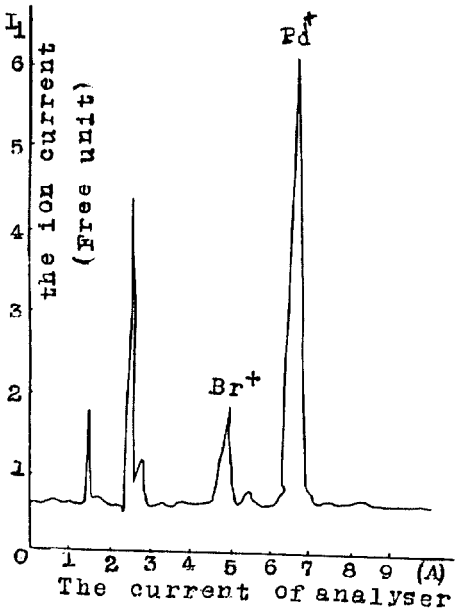

Fig.3 The ion mass spectrum of Pd + BBr_3

the metal no direct expose in plasma. Although gas of halogen into discharge chamber after pass through 4 - 1, the halogen occur chemical reaction with metal minlly is neutral particles. The ion mass spectrum of Be and Pd are done use by same method with front, for example, Fig.5 and Fig.6.

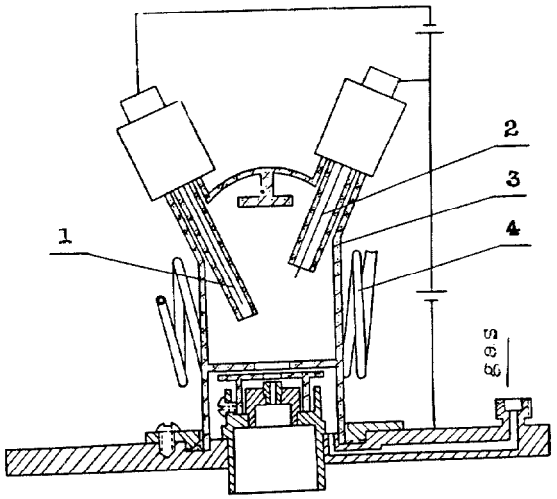

Fig.4 A structure of chemistry reaction in non plasma range.
(1) The metal of producing require ion; (2) The anod; (3) The quartz glass discharge chamber; (4) The coil of the r.f oscillator.

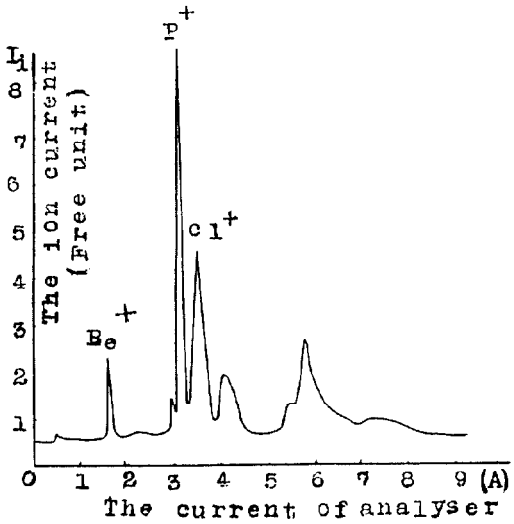

Fig.5 The ion mass spectrum of Be + PCl_3

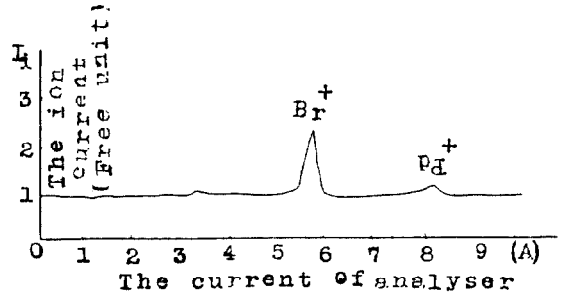

Fig.6 The ion mass spectrum of Pd + BBr_3

One can see from experimental results, the plasma chemistry reaction is applied, metal ion content proportion higher in ion beam than non plasma range chemical reaction. Such as, Be, the plasma chemistry reaction Be^+ occupy 37% ; non plasma range chemical reaction Be^+ only occupy 8.4%. Pd, the plasma chemistry reaction, Pd^+ occupy 44% ; non plasma range chemical reaction Pd^+ small than 10%.

3. Applied case of the plasma chemistry reaction

3.1 Applied the results at the ion source bench

By the use of the structure of Fig.1, The ion drawn at the ion source bench are: Re^+, W^+, Mo^+, Pd^+, Pt^+, Ta^+, Au^+, Ag, Ti^+, Cr^+, V^+, Fe^+, Cu^+, Si^+, Al^+, Be^+, Mg^+, Ga^+, In^+, Bi^+ and Li^+, and the drawn ion of the rare earth elements are: Y^+, Ce^+, Nd^+, and so on.

Graphs shown in Fig.7 to Fig.9 are the ion mass spectrum of V, Li and Y.

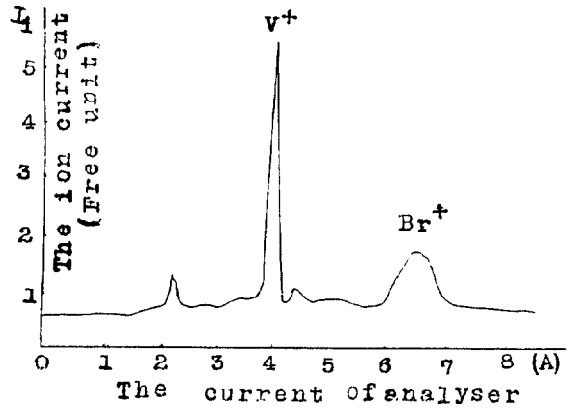

Fig.7 The ion mass spectrum of V + BBr_3

3.2 Used cases at ion implanter

This technique have been used at a 40Okev ion implanter in Beijing normal university for several years. It is stable in oppration and becomes a ripe technology. Part of the results for the ion current intensity at the target after passing through the magnet analyser were list in the table, for some kind of ions good results have been obtained.

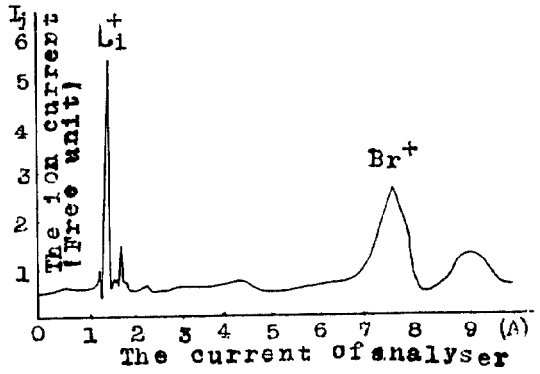

Fig.8 The ion mass spectrum of Li + BBr_3

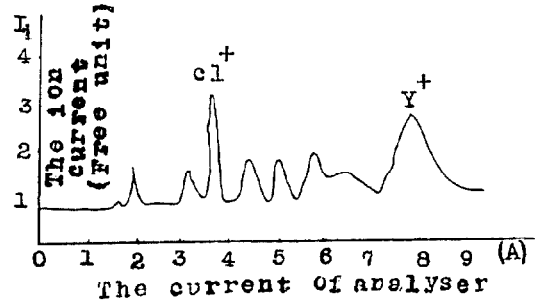

Fig.9 The ion mass spectrum of Y + CCl_4

The table of ion current intensity of part metals at the target in a 40Okev ion implanter

Ions :	Ti^+	Pd^+	$^{69}Ga^+$	$^{71}Ga^+$	Bi^+	In^+
Ion current intensity (μA):	100	120	50	33	85	300
$^{56}Fe^+$	$^{57}Fe^+$	Be^+	$^7Li^+$	$^6Li^+$	Ta^+	Y^+
54	2	150	130	3	12	30

4. Concluding remaks

There are many favourable factors of plasma can be utilized than non plasma range, specially the high-energy particles[3] and activeted particles[4]. By applying a plasma chenical reaction technique, to draw ion beams from a r.f ion source, the problem of drawing ions of metals with higher volatization temperature are solved. It has its own

merit. Since it used quartz glass discharge chamber, the chemical property of the quartz glass is more steady than that metals, the metals that is no need to produce ions can be shielded and can not be exposed to plasma, then useful metal ion content is higher in the draw ion beam. The noble metals which are not exhausted one time can be used continuously in next time. It is no need to compose metals into compounds before putting them in discharge chamber. For this reasion, it has advantages of simplicity the convenience and the economy. This technology can be used at ordinary ion implanters and accelerators with r.f ion source, provided some improvement of these machines is made, so as to expend usage and bring into full play of the machines and raise the economic benefit.

Reference

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