MULTIBEAM RF ION SOURCE WITH GROUNDED RF GENERATOR FOR HIGH CURRENT ACCELERATORS AND NEUTRON GENERATORS

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Abstract

A multibeam RF ion source with grounded meter range RF generator was developed and experienced in MEPhI [1]. The source, besides direct assignment, can be used for the ion implantation, for manufacture of solar batteries etc. For example, during a target irradiation in neutron generators with a deuton beam, target longevity essentially (in some times) increases due to dispersion uniformity rising.

1. SOURCE DESIGN

The scheme of source design is shown on Figure 1. The facility consists of the vacuum container 1 and a cylindrical $\lambda/2$ spiral loaded RF resonator 2 mounted on insulator 3 by means of holder 4. The resonator operating frequency is defined by the spiral length and can be chosen in (35÷150) MHz range. High voltage on resonator makes up to 130 kV. The dielectric (quartz glass) cylindrical discharge chamber 5 with a diameter of 45 mm and length of 60 mm is placed inside the spiral.

An ions are extracting from plasma through the holes in extracting electrode 6 which is fixed by means of insulator 7 to holder 4. High voltage is supplied to resonator and extraction electrode through partition insulator 8. The difference between resonator U_R and electrode 6 U_e potentials makes extraction voltage U_{extr}.

To rise plasma density a ring-shaped permanent magnet 9 is placed inside of resonator and holes in electrode 6 are supplied with special insets, which are fabricated from magnetic steel. All another metallic elements of source are fabricated from nonmagnetic materials (stainless steel and copper). Beam parameters measurement were performed by means of beam control system 10.

Distinctive features of the source design are insulated RF power input unit 11 and system of working gas filling12 into the chamber. In this case RF generator has a potential of ground, that allows to simplify the generator and gas filling system design and to increase RF power in the resonator up to some tens of kW. Use of the resonator provides practically complete absorption of RF power by plasma, increasing a degree of its ionisation and density.

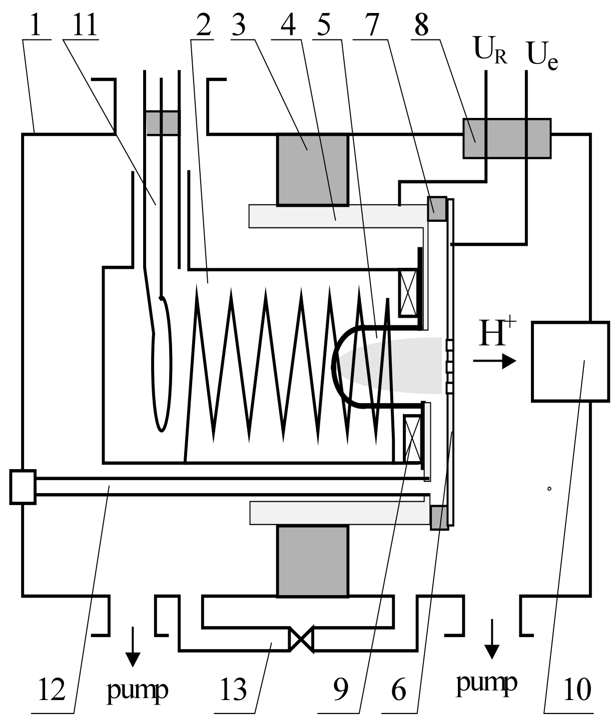

Figure 1 : The scheme of source design (see text)

An insulated RF power input unit 11 constitute coaxial design with circle coupling loop at the end.

A system of working gas filling 12 is fabricated from Teflon pipe. It’s length was chosen proceeding from the highest electrical strength.

An insulator 3 divides vacuum container 1 into two independent vacuum compartments. At the back section (with resonator) working vacuum is not worse than 10^{-4} Pa, and in the forward section - not worse than 10^{-2} Pa. The pumping of sections is carried out by means of sputter-ion pump and turbo-pump correspondingly. At the stage of preliminary pumping pass-by system 13 is used.
Main units of source have following sizes:
resonator: diameter - 170 mm, length - 260 mm;
container: diameter - 520 mm, length - 500 mm.
Container is installed on the turbo pump module with sizes 1m x 1m x 1m.

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2 EXPERIMENTAL RESULTS

In experiments the extracting electrode had 6 holes with a diameter of 2 mm placed over the circle with a diameter of 30 mm and 1 hole at centre. The following results were obtained. In a continuous mode: ion energy (defined by resonator potential) W_{H+} = 7 kV, extraction voltage U_{extr} = 5 kV, ion current I_{H+} = 5mA. In a pulse mode: W_{H+}= 70 kV, U_{extr} = 3 kV, I_{H+} = 40 mA. Working gas was hydrogen, particles - H^+ ions. The average RF power level in resonator was about 70 W in both cases (continious RF generator was used). In comparison with similar devices RF ion source developed has the increased durability, gas profitability and power efficiency[2].

3 REFERENCES

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