8 - 22 Progress of Intense Beam Ion Source Development and Technologies

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Intense ion beam production is of high importance for versatile applications various from accelerator injector to Secondary Ion Mass Spectrometry (SIMS). For these purposes, different type of intense beam ion sources has been developed based on 13.56 MHz Radio-Frequency (RF) and 2.45 GHz microwave scheme.

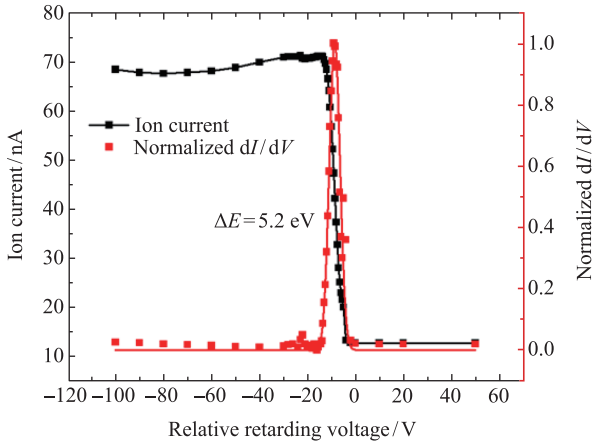

Fig. 1 (color online) Ion dispersion of negative oxygen ion beam.

RF type plasma features simple structure, high plasma density and low plasma temperature, which is suitable for negative ion beam production (O^-, O_2^-). The use of RF sources for primary ion beam have been described since the beginnings of SIMS. In RF sources, the plasma is inductively coupled to an RF antenna and different designs have been tested. However, to date one of the major drawbacks of RF plasma-based sources for micro focusing application was the large energy dispersion of ions (30 ∼ 500 eV) which caused chromatic aberration and therefore prevented the formation of a sufficiently small primary ion beam suitable for SIMS applications. Very compact RF type ion source using planar coil antenna has been developed at IMP for negative molecular oxygen ion beam production. The problem of ion dispersion has been solved, and the ion dispersion measurement result of oxygen ion beam is shown in Fig. 1.

In terms of high intensity positive ion beam production (H^+, H_2^+, Ar^+ *etc.*), 2.45 GHz microwave power exited plasma has been widely used. At IMP, we developed 2.45 GHz plasma source with both ridged waveguide and coaxial antenna coupling schemes tested successfully with intense beam production. With 2.45 GHz microwave plasma, ridged waveguide can support higher power coupling of high efficiency that leads to the production of intense hydrogen beams up to 100 emA, whereas the coaxial antenna is less efficient in power coupling to plasma but can leads to attractive ion source compactness with reasonable beam extraction of several emA. During 2022, the commissioning of High Power Platform started, and CW proton beam of target (32 mA @210 kV, 17 mA @240 kV) was achieved. PREF ion source produced proton beam with 10 mA @20 kV, 1∼20 Hz, with the required beam Twiss parameters. The optimized coaxial antenna ion source produced H^+ ion beam 2 mA@30 keV, Ar^+ ion beam 1 mA@30 keV with microwave power 150 W.

References

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[2] Y. Zhou, Y. J. Zhai, Q. Y. Jin, et al, Rev. Sci. Instrum., 94(2023)043302.