Energy Analysis of H_3^+ Ion Beam Emitted from Gas field ionization source

Hitachi, Ltd., Research & Development Group[1], Hitachi High-Tech Science Co.[2]
○Shinichi Matsubara[1], Hiroyasu Shichi[1], Tomihiro Hashizume[1] and Anto Yasaka[2]
E-mail: shinichi.matsubara.zm@hitachi.com

Techniques for focusing ion beams are very important today in terms of industry and academia. Basically, they are often used for sample processing (for example, TEM lamella) as well as for observation of sample surface. For both applications, it is very important how finely the beam can be focused. The energy dispersion of the ion beam is an important parameter which determines how finely the beam can be focused. A gas field ionization ion source has the energy dispersion smaller than other ion sources such as a liquid metal ion source and its brightness is also as high as the field emission electron source. Our group has studied hydrogen gas field ion source. Three types of hydrogen ions, i.e. , H^+, H_2^+ and H_3^+ can be released from the hydrogen gas field ionization ion source[1]. It is known that H_3^+ has smaller energy dispersion than other hydrogen ions[2] and unfortunately H_3^+ has been considered to be less suitable for practical use because of its smaller emission amount than other ions. However, we have reported that when the emitter tip is sharpened to the atomic level, H_3^+ gives the largest emission amount among the three ions with very narrow extraction voltage range. In this condition the probe current for a practical use can be achieved[3, 4].

We evaluated the energy dispersion of the H_3^+ beam by using the retarding method for repelling the beam with the same potential as the beam energy. Evaluation was carried out by applying a voltage (retarding voltage) almost equivalent to the beam acceleration voltage to the electrode of the electrostatic objective lens of an ion microscope apparatus that can actually focus the ion beam. We achevied verifying the convergence performance of H_3^+ more directly compared with the case of using field ion microscope with energy spectroscope. In this presentation, we will report on the details of this evaluation method, especially the relationship between beam limiting and measurement resolution of energy dispersion and the relation between extraction voltage and energy dispersion width.

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