Formation of several tens keV light ion beams with 0.1 μm in diameter using a submicron ion beam system with double acceleration-lenses

Y. Ishii, A. Isoya, S. Ozawa, K. Arakawa and M. Fukuda

Japan Atomic Energy Research Institute, 1233, Watanuki-machi, takasaki, Gunma, 370-1292, Japan

A submicron ion beam system has been developed for formation of several tens keV light ion beams with 0.1 μm in diameter. The system consists of a duoplasmatron-type ion source, double acceleration-lenses and a beam width measurement system.

An ion beam size generated from a plasma-type ion source, which is an object beam size to a focusing lens, is over 0.1 mm in diameter because of a limitation of extracting ion beams from an extraction electrode hole with tens micro-meter or less size. Due to forming the 0.1 μm beam sizes from the object beam one, high demagnification lenses were required in the submicron ion beam system. The double acceleration-lenses were designed to achieve the high demagnification of over 10^3.

So far ion beam sizes of 0.16 μm in diameter for 45 keV H^+ beams were obtained by the introduction of a direct extraction method which led to generate several hundreds eV ion beam with a divergence angle of 10^{-3} rad-order and an energy spread within 2 eV in the ion source. The beam width was, however, 1.6 times greater than the aiming beam size of the 0.1 μm in diameter. Some experiments for beam width measurements suggest that the main obstacle of the beam width reduction lie in the condition of the direct extraction method. The ion beam trajectories from the ion beam extraction electrode to the entrance of the double acceleration-lenses were calculated to optimize the lens parameters. Formation of the 46 keV H_2^+ beams with 0.1 μm in diameter has been achieved using the calculated parameters for beam width reduction.