Measurement of Ultra-low Ion-Beam Energy

P. Thopan¹*, D. Suwannakachorn¹, S. Singkarat¹,² and L.D. Yu¹,²*

¹Plasma and Beam Physics Research Facility, Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand
²Thailand Center of Excellence in Physics, Commission on Higher Education, 28 Si Ayutthaya Road, Bangkok 10400, Thailand

*Corresponding authors. E-mail: thopan_w@hotmail.com, yuld@fnrf.science.cm.uc.ac.th

ABSTRACT

Measurement of ion-beam energy is important for assuring equipment operation. When an ion beam is decelerated, its energy becomes very low; the measurement of such low energy is investigated here. Low ion-beam energy has been measured using a retarding field and detector. This research, however, used a deflecting electrostatic field, a simpler and more accurate method. The basic principle of the electrostatic-field application for measuring ion-beam energy is that when an ion beam passes through parallel plates of the electrical field, the beam will be bent from its axial trajectory as a function of the applied field. The bending distance of the ion beam can be used to determine the ion-beam energy. Results of measuring ion-beam energy in this study were compared with theory and simulation results. The SIMION program version 8.0 was used to perform the simulation. A system to measure the ion-beam energy was designed, constructed and installed. The system consisted of a pair of parallel electrode plates, a copper rod measurement piece, a vernier caliper, a stepping motor and a webcam-camera. The entire system was installed under an ion-beam deceleration lens inside the big chamber of the 30-kV bioengineering vertical ion-beam line (CMU3) at Chiang Mai University. The copper rod was moved by the stepping motor to measure the ion-beam current profile, which depended on the beam spot position. The beam profiles were compared between the plates, with and without the electrostatic field, for extracting the ion-beam bending distance and then the ion-beam energy. The ion-beam current, which was on order of 10 nA, was measured by a digital nano-ammeter. Argon ion beams at various energies, ranging from 10 to 20 keV, passed through the deceleration lens resulting in ion energy lower than 1 keV. The measurement results were in good agreement with theoretical and simulated results, demonstrating that the method worked well.

Keywords: Ion-beam energy, Beam current profile, SIMION program, Deceleration lens.