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Plasma parameter measurement during efficiently producing multicharged ions by selectively heating low-Z ions on Electron Cyclotron Resonance Ion Source in mixing low-Z gases

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Electron Cyclotron Resonance Ion Sources (ECRIS) have been widely applied in various fields, including particle accelerators, superheavy element research, cancer therapy, and ion implantation. We are conducting research on the efficient production of multicharged ion beams on 2.45 GHz ECRIS. Gas mixing with low-Z gases is known as an effective method for enhancing the production of multicharged ions, and one of its possible mechanisms is the ion cooling effect. Focusing on this effect, we attempt to amplify its effect by selectively heating low-Z gases using ion cyclotron resonance (ICR). In this experiment, we used Xe as the operating gas and introduced low-Z gases that is He or Ar. Low-frequency RF power was applied through an ICR antenna which six turn antenna made of Cu covered by Al2O3. The frequencies of ion cyclotron resonance is 400 kHz for He+ and 40 kHz for Ar+ . The charge state distribution (CSD) based on ion beam current showed an increase in the yield of multicharged ions, with a more significant enhancement when He^+ ions were heated than that of Ar^+ case. We measured the plasma parameter of mixing gas by using a Langmuir probe, both with and without low-frequency RF. Electron temperatures and electron densities increase in both Xe/He and Xe/Ar plasmas. Xe/He case exhibited a more significant increase. These trends are in good agreement with enhancement of ion beam currents.In this paper, we will present details of these experimental results, and also plan to measure ion energy inside the ion source by using ion-sensitive probe method.

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