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Progress in the development of negative ion beam source in Korea

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In Korea, as part of the ITER non-procurement core technology development project, the development of a negative ion beam source is in progress.
The overall period can be divided into 3 phases corresponding to 3 prototype negative ion beam sources. In the first phase, a Cs-free ion source using 2 MHz RF up to 10 kW was developed. A 4 mm thick water-cooled Faraday shield was inserted inside an Al_2O_3 cylinder with a diameter of 200 mm for CW operation. Beam extraction experiments were performed with a 3-grid system designed for a beam energy of 50 keV. In the second phase, the Al_2O_3 cylinder was replaced with a smaller 150 mm diameter aluminum nitride (AlN) cylinder and a thin copper Faraday shield was inserted without water cooling to improve RF power coupling. Evaporated Cs was injected by a Cs dispenser and the beam current enhancement was achieved. However, kW-level RF power was insufficient for the high-current negative ion beam extraction. The plasma grid (PG) temperature was also not controlled and the surface conditions for efficient negative ion surface production were not met. In the third phase, the whole system was newly developed. The 2 MHz RF power supply was replaced by a 400 kHz RF power supply up to 50 kW. In addition, a 3-grid system for 200 keV beam energy was developed. Our approach is first to generate higher density plasmas by increasing the input RF power and removing the Faraday shield. To protect the AlN cylinder, it adopts a pulsed operating system that generates a pulsed plasma discharge and minimizes the heat load of the plasma. Once high density plasma generation is achieved, beam extraction experiments using Cs injection and PG temperature control is planned. %are carried out.
Research on system upgrades for long pulse or steady state operation is also in progress. Plasma diagnostics using an RF-compensated Langmuir probe was performed as the first step in the approach to the new system. As the RF power was increased from about 4 kW to 30 kW, measured plasma densities were increased from on the order of 10^{17} m^{-3} to 10^{18} m^{-3} and (effective) electron temperatures were about 7 eV, indicating slightly decreasing behavior. Detailed experimental results are presented and discussed.

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