C12A7エレクトライド製プラズマ電極を有するH⁻源
Source of H⁻ Ions Equipped with the C12A7 Electride Plasma Electrode

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Motivations

Intense beam sources of negative hydrogen (H^-) and negative deuterium ions (D^-) are being developed for applications to high-energy proton accelerators and neutral beam injectors for plasma heating. Stable operation of these sources requires Cs injection into the source plasma and the Cs consumption rate is one of the important factors for choosing the source type; a smaller consumption rate is favored for keeping the Cs inventory in the source and accelerator system smaller as the accumulation of Cs may cause breakdowns of the high-voltage systems. Thus, low work function materials are studied as substitutes for metallic Cs, and we have demonstrated the effectiveness of $12CaO\text{-}7Al_2O_3$ (C12A7) electride for H^- surface production.[1] The next stage demonstrates the performance of an ion source equipped with a C12A7, and we report the status of R&D of this test source.

Source Design

The structure shown in Fig. 1 generates magnetized microwave discharge plasmas with the input power smaller than 50 W. Nd-Fe permanent magnets produce an axial magnetic field inside of a short section of 18 mm diameter stainless steel with the intensity realizing an electron cyclotron resonance (ECR) condition. The source maintains a plasma with a very low power reflection once the discharge is ignited. The metal sealed source is expected to produce impurity-free hydrogen plasma of low electron temperature and low plasma potential, which is currently being investigated using a Langmuir probe.

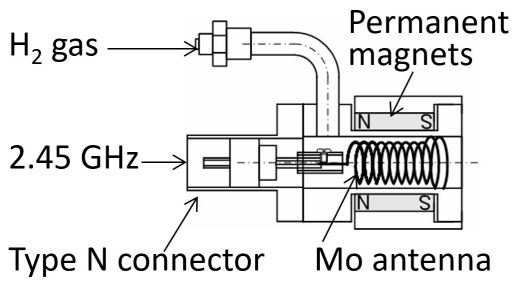

Fig. 1. Structure of the prototype source. ICF-34 conflat® flanges constitute a full metal sealed plasma source.

The prototype source serves as the plasma source to study fundamental processes associated with material plasma interaction. Based on the prototype source structure, and ion source that can put an electrical bias to the extraction electrode facing the plasma, or the plasma electrode, made of C12A7. The source has a compact size as indicated in the scale added to Fig. 2 and is made of aluminum to decrease the contamination of C12A7 electride surface by foreign materials. The 6 mm diameter H^- beam is extracted through the electride PE with the 45-degree tapered opening.

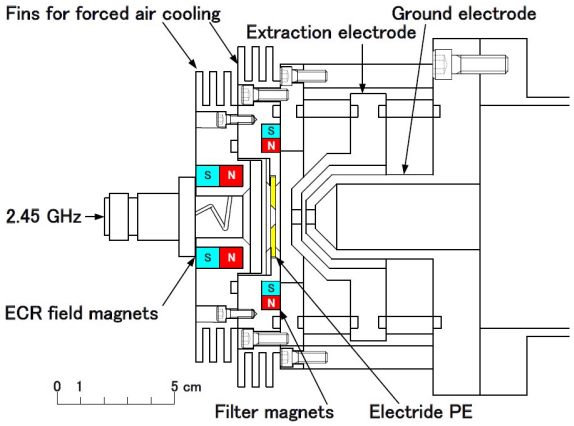

Fig. 2. Ion source to test C12A7 electride plasma electrode.

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Reference

1. M. Sasao *et al.* Appl. Phys. Express, **11**, 066201 (2018).