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水素原子・分子イオンと低仕事関数材料との相互作用

Interaction between atomic and molecular hydrogen ions and a low work function material

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Negative ion sources have been used to heat the LHD deuterium plasmas with Cs injected for enhancing negative hydrogen (H^-) ion current. For a stable operation of an N-NBI system at the DEMO test reactor stage, however, accumulation of Cs in the ions source can be a potential problem for shortening the reactor life. Non-Cs plasma grid (PG) materials have been proposed, and we have started our study on the C12A7 electride material.

The effective work function of C12A7 electride is as low as 2.4 eV. The material is chemically unstable against long-time exposure to atmosphere air so the surface is usually coated with a protective layer. Before the experiment, we removed the surface layer by heating the sample up to 715 ºC for more than 3 hours. The electride sample after the treatment was installed to the analyzer chamber of the beam-surface interaction device assembled at NIFS as shown in Fig.1. In this device, positive low-energy atomic and molecular hydrogen ions are extracted to bombard the sample target. The reflected ions from the sample target are detected by an angle resolved energy analyzed in a bending magnetic field. Energy spectra of the reflected positive and negative ions are measured by a single sweep of the voltage applied to the analyzer coil. The results showed that the C12A7 electride showed higher reflectivity of H^- ions compared to a Mo sample at a low-incident energy and low-incident angle condition. (See Fig. 2.) Reflections of H^- ions due to H_2^+ and H_3^+ ion injections were found more efficient compared to the reflection from H^+ ion injection.

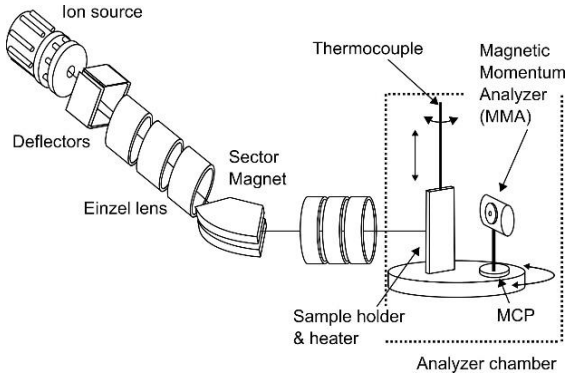

Fig.1. A schematic diagram of the reflection particle experiment setup of the beam-surface interaction device at NIFS.

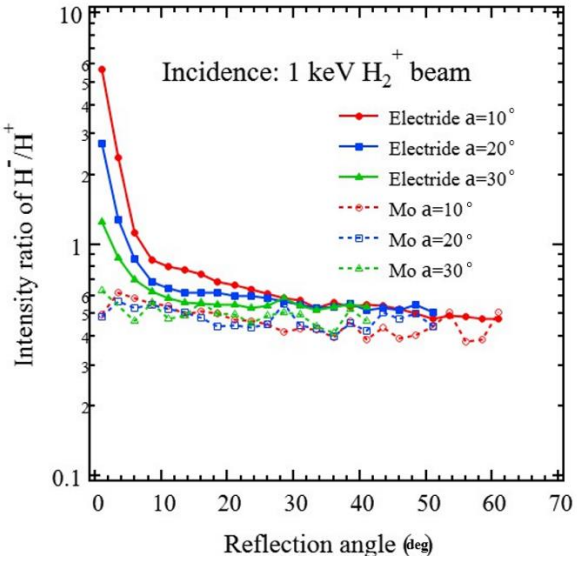

Fig.2. Reflection intensity ratio H^-/H^+ in electride and Mo with an incident H_2^+ beam of 1 keV. The incident and reflection angles are defined for the line along the incident beam.