Effect of vibrationally-excited molecules on D^-/H^- production in a pure volume production source

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D^-/H^- negative-ion sources for neutral-beam injector (NBI) are required for efficient production and extraction of D^-/H^-. In a pure volume production with an external magnetic filter, D^- and H^- are produced by the dissociative attachment of slow plasma electrons to vibrationally-excited molecules, $D_2(v")$ and $H_2(v")$ [1]. The D^- production is almost the same in the production process as the well-researched H^- production [2-4]. But optimum parameters for the D^- production are slightly different from those for the H^- production. Comparison of the plasma parameters and production properties of $D_2(v")$ and $H_2(v")$ in between D_2 and H_2 plasmas is investigated [5].

A hydrogen plasma is generated by a direct-current arc discharge in a rectangular chamber of 25×25 cm in cross section and 19 cm in length. An external magnetic filter separates a downstream area with a low electron temperature from the discharge area with a high electron temperature around four tungsten filaments. The D^- and H^- densities and the $D_2(v")$ and $H_2(v")$ densities are estimated by a laser photodetachment method and an ultraviolet emission spectroscopy, respectively, and the current densities extracted is analyzed behind the extracted electrode. The electron densities in the both areas almost depend on the discharge power. The discharge voltage V_d is changed under fixed the discharge power, and VUV spectra in the discharge area are measured. The amounts of $H_2(v")$ normalized by the electron density depending on the electron beam energy $e(\phi_s - V_d)$ around the filaments are shown in Fig. 1, where the discharge power is fixed at 300, 400, 500, 600, and 700 W. The efficient of $H_2(v")$ production per electron is almost the same independently of the discharge power. The gradient of $H_2(v")$ is different in the vicinity of the energy boundary of 50 eV. Relations among the density and temperature of electrons, the negative-ion densities, the extracted current densities, and the excited-molecule densities will be discussed in the presentation.

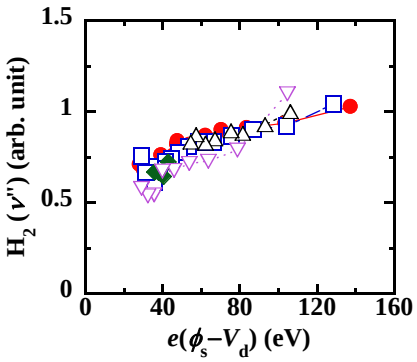

Fig.1: $H_2(v")$ normalized by the electron density depending on electron-beam energy.

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