

**Title:**

Development of Plasma Window

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**Abstract:**

A Plasma Window (PW) [1] has been developed aiming to confine gases at a pressure higher than 1 atm in a beam line vacuum as a windowless gas charge stripper. It was found that charge states of heavy ion in hydrogen or helium (He) gases become considerably greater than those in heavier gases such as N<sub>2</sub> and Ar [2-4]. However, since H<sub>2</sub> and He gases have high diffusion speed, realization of windowless thick H<sub>2</sub> and He gas targets in a beam line vacuum is quite hard with a conventionally differential pumping system.

A PW would help to improve a differential pumping efficiency comparing to that of conventional system without PW for two reasons: 1) based on the state equation of ideal gas, the pressure of arc plasma at high temperature ( $T=12000$  K) corresponds to the gas pressure at room temperature ( $T=300$  K) with 1/40 of its density, 2) the temperature dependence of plasma viscosity is greater than that of normal gas. PW has a porthole with 2-mm diameter and 43-mm length at the center for beam passing. The gas target region was connected to a differentially pumped chamber by this porthole. The gas flow through a PW from the gas target region to the vacuum chamber can be greatly reduced by high temperature arc plasma (12000~15000 K) filled in the channel.

We constructed a differential pumping system with the PW using a gas cell filled with He or Ar gas at a pressure greater than 0.2 atm. The efficiency of differential pumping was evaluated changing the porthole diameter from 2 mm to 6 mm. The experimental results will be presented.

[1] A. Hershcovitch (1995) J. Appl. Phys. 78:5283.

[2] H. Okuno et al. (2011) Phys. Rev. ST Accel. Beams 14:033503.

[3] H. Imao et al. (2012) Phys. Rev. ST Accel. Beams 15:123501.

[4] H. Kuboki et al. (2014) to be published.