

## S63. Trapping of Helium Gas in the LHD

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It is known that high-energy hydrogen atoms are implanted into a wall of a vacuum vessel during plasma discharge. However, in general, helium atoms are not implanted into a wall. And helium gas is easily released from a surface of a wall, because of its small activation energy. So it is believed that helium gas is not trapped in a vacuum vessel. However, in a case of LHD experiments, missing of helium atoms and long time outgassing of helium gas has been observed.

Neutral gas pressure in the LHD vacuum vessel has been measured by Fast Ionization Gauge (FIG), which is operational in high magnetic field. To combine with data of a gas puffing system and pumping system of the LHD, particle balance in a vacuum vessel can be calculated. At the first stage of the LHD experiment, no missing of the helium gas had been reported 1). However it has been observed during the third campaign of the LHD experiment that an almost half of input helium gas has lost after a plasma discharge. Fig1 shows comparisons between calculated total amount of helium atom in the vacuum vessel and total amount of helium atoms, which is measured by FIG. In the case of helium gas puffing without plasma, no missing has been observed. It points out that high energy helium atom is a key of missing atoms. For conditioning of the vacuum vessel wall, helium grow discharge or hydrogen grow discharge has been carried out every night before the LHD experiment. The grow discharge had been stopped at 3:00a.m., and then the gas has been pumped out. Fig 2 shows partial pressures of helium and hydrogen gas at 8:40a.m. – 8:50a.m. after hydrogen and helium grow discharges. These graphs point out that helium and hydrogen gases have been released from the wall continuously even after more than 5 hour pumping. In a case of hydrogen gas, this effect is usual. However, in a case of helium gas, this effect cannot be explained by an outgassing from a surface of the wall. The helium outgassing rate is estimated to be  $1.36 \times 10^{-4} \text{ Pam}^3/\text{s}$ .

From point of view of solid physics, helium atoms cannot be trapped in lattice. So where and how the helium atoms in the LHD have been trapped? Hino reported the result of implantation experiment of helium atom with an energy of 5keV into a graphite plate, and the implantation has been observed 2). Thus, a carbon in the LHD vacuum vessel is a candidate of trapping place of the helium atom.

High-energy helium atom, which has been produced by charge exchange interaction, has been implanted into carbon in the vacuum vessel, and trapped in a lattice defect or small crack. This may be a scenario of trapped mechanism of helium atom in the LHD

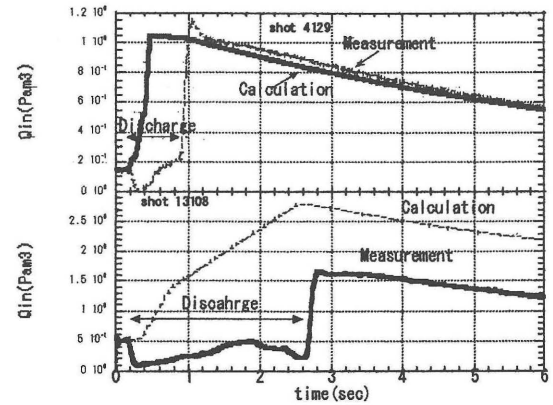


Fig.1. Total amounts of He gas of first campaign (shot 4129) and third campaign (shot 13108)

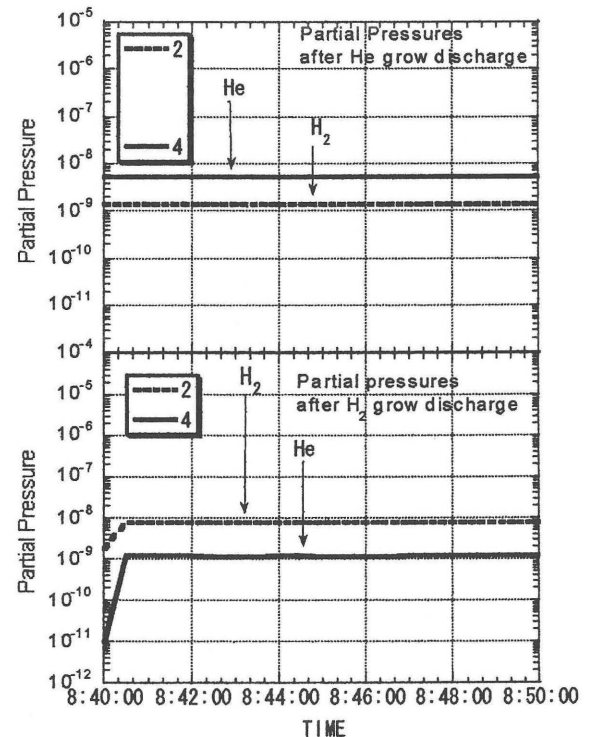


Fig.2. Partial pressures in the LHD vacuum vessel before plasma discharge experiment

### Reference

- 1) H.Suzuki et al., J. Plasma Fusion Res. SERIES, Vol.3 (2000) 250
- 2)T. Hino et al., J. Nucl Mater. 266-269(1999) 538