4. Basic, Applied and Innovative Research

As an inter-university research institute, NIFS activates collaborations with researchers in universities as well as conducting world-wide top level researches. The collaboration programs in basic, applied, and innovative research support research projects motivated by collaboration researchers in universities. It is also important to establish the academic research base for various scientific fields related to fusion science and to maintain a powerful scientific community to support the research. Programmatic and financial support to researchers in universities who work for small projects are important. As an inter-university research institute in fusion science, NIFS performs such an important role and the programs in basic, applied, and innovative research are prepared for this purpose.

For basic plasma science, NIFS operates several experimental devices and offers opportunities to utilize them in the collaboration program for university researchers. A middle-size plasma experimental device HYPER-I is prepared for basic plasma research. In addition to the collaboration support with experimental facilities in NIFS, various small experiments conducted in universities for basic and applied plasma science are supported by NIFS for its operational cost and most importantly for providing the community network relationship for research information exchange and personnel exchange.

Measurements of velocity distribution function using the HYPER-I device

The experiments in the HYPER-I device [1] have been carried out to understand transport phenomena and structure formation in inhomogeneous plasma, in which these issues are significant for the plasma confinement in fusion devices and for various plasma applications. Focusing on the effect of neutral particle flow on plasma structure formation, we have directly measured the velocity distribution function of neutral particles in plasma using high accuracy laser-induced fluorescence spectroscopy. Recently, the asymmetry of velocity distribution function has been observed in the neutral depletion structure as shown in Fig. 1 (a). It is interesting that a simple relation between the skewness and the inhomogeneity-induced flow holds as shown in Fig. 1 (b). The result indicates that the higher order geometric form factor has physical meaning in an inhomogeneous system, and this simple method using the skewness may be effective to investigate the transport phenomena [2].

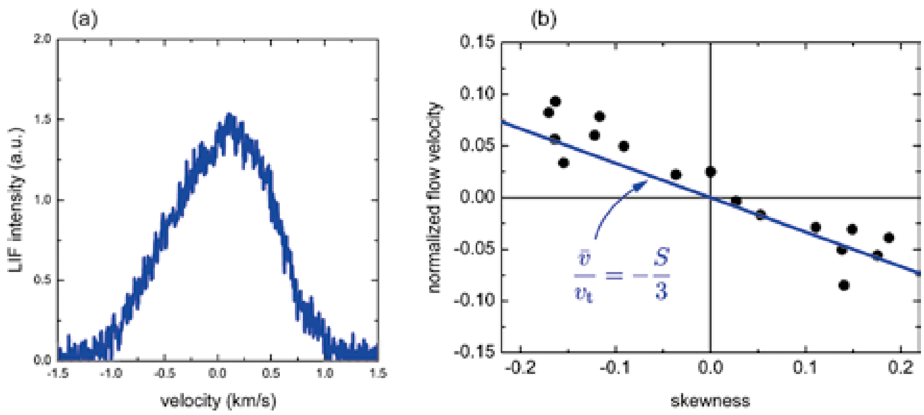

Fig. 1 (a) Asymmetry velocity distribution function in an argon plasma and (b) normalized flow velocity as a function of skewness. The data in (a) and (b) are the same with that in Fig. 4 (d) and Fig. 7 of Ref. [2].

Plasma window for novel vacuum interface

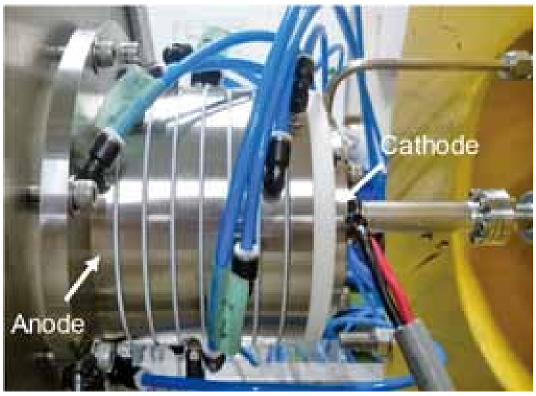

Fig. 2 TPD plasma source for plasma window.

Plasma window has been expected as a virtual interface to separate vacuum (10 Pa) from atmospheric condition (100 kPa) without a large pumping system. This novel vacuum interface is realized by thermal arc discharges, by which charged particles and x-ray are transmitted into the atmospheric side, while the air cannot flow into the vacuum chamber. For application of plasma windows, we constructed a compact TPD (Test plasma by Direct current) apparatus (FIG.2). The discharge source generated high-density Ar plasmas in an opening of 3 mm (T_e~1 eV, n_e~10^{17} cm^{-3}). We demonstrated the pressure gradient between the vacuum chamber (100 Pa) and atmosphere (100 kPa) at 50-A discharge through 100-mm plasma channel. Therefore, the plasma window developed can be applied to an electron beam welding under air atmosphere, which is usually performed in vacuum environment [3].

Development of Faraday material for the advanced plasma diagnostics

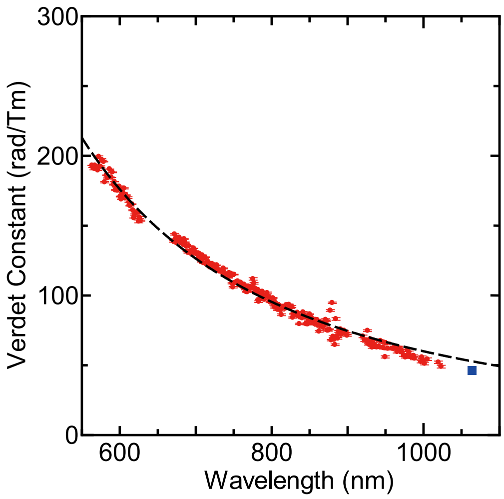

Fig. 3 Verdet constant of Ho_2O_3 ceramics as a function of wavelength. Cited from Ref. [4].

A laser-aided diagnostics method is one of the reliable methods for measuring the plasma parameters in fusion research. In this method, a laser light source is the most important factor for the performance of measurement results. In this study, we have developed the new material of the transparent Ho_2O_3 ceramics for a Faraday rotator, which is the key optics for high power lasers. This report for fabrication and evaluation in this material is the first, to the best of our knowledge [4]. The transparent Ho2O3 ceramics have the excellent magneto-optic properties which are the most important propriety for a Faraday rotator. The value of the Verdet constant representing the magneto-optic propriety at 1064 nm is 46.3 rad/Tm which is about 1.3 times higher than that of the standard material of terbium gallium garnet (TGG) (Fig.3). From the result, this material has potential as a new Faraday rotator for high-average power lasers.

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(I. Murakami)