§3. In-situ Transmittance Measurement of the LHD Thomson Scattering View Window

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In order to obtain the accurate values of electron temperature (*Te*) and density (*ne*) from the Thomson scattered (TS) light signals, many efforts are required to eliminate all conceivable sources of systematic errors. Although most of the systematic errors are minimized by calibrating all optical parameters before the start of an experimental run, some still arise from the gradual variations of the instrument parameters, e.g., transmittance/ reflectance of the optical components or the gain of the light detectors. The best well-known such a variation is the transmittance of the viewing window, which is caused by gradual thin film coating on the plasma-facing surface. To alleviate this problem to some extent, we adopted the following method [1]. A glass plate (cover glass) is placed in front of the view window and when its surface is exposed to several thousand plasma shots (about half the annual shot numbers), it is replaced in vacuum with a new one set beneath. From the past experience, we estimate that this method guarantees the measurement accuracies better than 10% if the cover glass is regularly replaced. Nevertheless, it is better to know the transmittance of the cover glass at any time during plasma experiment, which enables us to correct the scattered signal magnitudes as well as to give the timing when we should replace the cover glass. In order to realize this improvement, we set up the optics schematically shown in Fig. 2. A corner cube reflector is attached to near the center of the shutter plate that is closed during the grow discharge cleaning to protect the cover glass against plasma sputtering. A collimated probe light, delivered from a tungsten lump via a 40m optical fiber of 400μm in diameter, goes around passing the view window and the cover glass two times. The returned light is reflected 90° by a thin beam splitter and is focused by a small lens onto the tip of a 40 m long optical fiber of 400 μm in diameter. The opposite end of the optical fiber is connected to a fiber-spectrometer, the output of which is designate as Sp(λ). The absolute wavelength-dependent transmittance T(λ,0) is first measured in air before setting the cover-glass. The time variation of the wavelength dependent transmittance is calculated as T(λ,*t*)=T(λ,0)Sp(λ,*t*)/Sp(λ,0), where *t* is the time of measurement.

We examined the reproducibility of the measurement by repeating the open-close cycle of the shutter. It was found that the precise positioning of the corner cube reflector is essential for the good reproducibility. Replacement of the rubber ring stopper, which is used to set the highest position of the shutter, with a SUS304 ring resulted in the much better reproducibility. Power supply to the tungsten lump with accuracy better than 0.1% and the stable room temperature around the spectrometer are also necessary for the accurate measurement. With these cautions, a series of repeated measurements reproduce themselves within 3 % root-mean-square variation as shown in Fig.3. Thus, the systematic error in *ne* caused by the transparency drop in the cover glass can be kept within 3 % by a suitable correction.

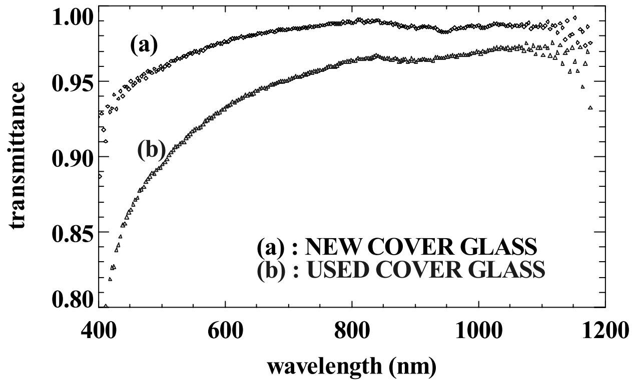

Fig. 1. An example of the transmittance change of a cover glass after exposure to plasma discharges of a three-month experiment.

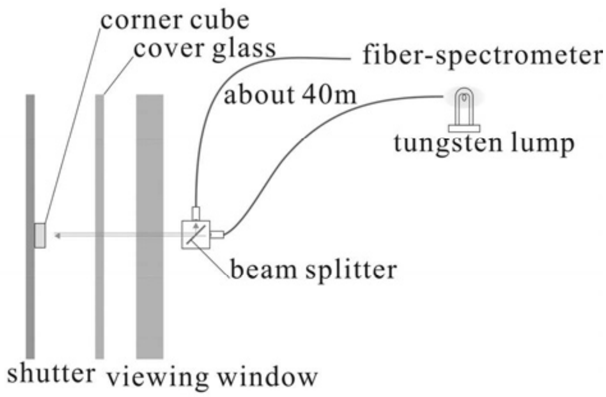

Fig. 2. Schematics of optical setup used for measuring the transmittance of the cover-glass plus view window..

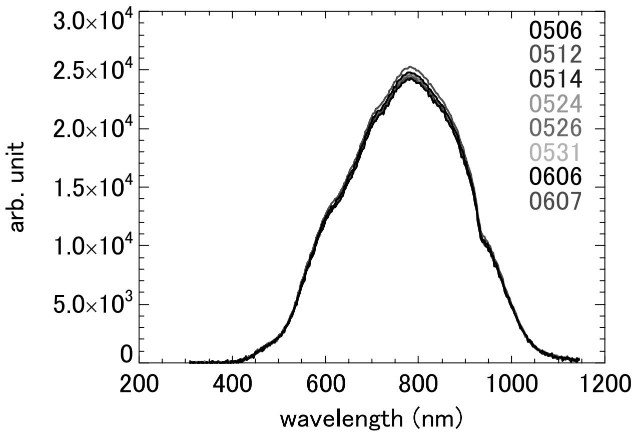

Fig.3 Demonstration of the reproducibility of repeated measurements.

[1] K. Narihara, et al., Rev. Sci. Instrum., **72**, (2001) 1122.