

§14. Characteristics of Window Materials in Terahertz Regime for the Application of High-Temperature Fusion Plasma Experiments

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For utilizing the terahertz wave for high-temperature plasma diagnostics, several developments of device components are needed. For example, the high power output source, low transmission loss waveguide, fast response detection system, etc. These developments are kept going.^{1,2)} Also, we need to check the characteristic of materials for plasma diagnostic, because some of them are not usual for other terahertz wave application. Vacuum window is indeed one of the necessary components in fusion plasma experiments. Especially, we have a plan to apply a THz pulse (not continuous wave) for the plasma diagnostics. Since it has broad band continuous frequency components, the window material is demanded to be the low transmission loss in a whole frequency range. Now, we test vacuum windows of several materials which are used in current LHD.

A test is carried out by a THz time domain spectrometer (THz-TDS). There are several designs of THz-TDS system. Among them, an asynchronous optical sampling (ASOPS) technique has a possibility of time resolved measurements. In this time, we use a commercial ASOPS system (ADVANTEST TAS7500) which can be scanned in 8 ms and one sample data are provided by 4096 scanning for this window characteristic test.

The examples of the THz pulse waveform and frequency spectrum are shown in Fig. 1. Here, the pumped femtosecond laser output is around 30 mW, and the bias voltage of the emitting photoconductive antenna is 10 V. The shape of the frequency spectrum is that of a typical bow-tie antenna. The available output frequency components are up to 4 THz in this condition.

Four types of window are tested. A silica and fused silica windows are used in microwave diagnostics. A sapphire window is used for far-infrared interferometer. A quartz window is used for millimeter wave interferometer. All of them are the same as LHD installed one. The transmissivity of them are shown in Fig. 2. For a fusion plasma measurement, more than 1 THz frequency wave is planned to apply. Therefore, sapphire or quartz window are found to be available for THz pulse used plasma diagnostics.

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- 1) Tani, M. et al. : Ann. Rep. NIFS (2011-2012) 147.
- 2) Tani, M. et al. : Ann. Rep. NIFS (2012-2013) 178.

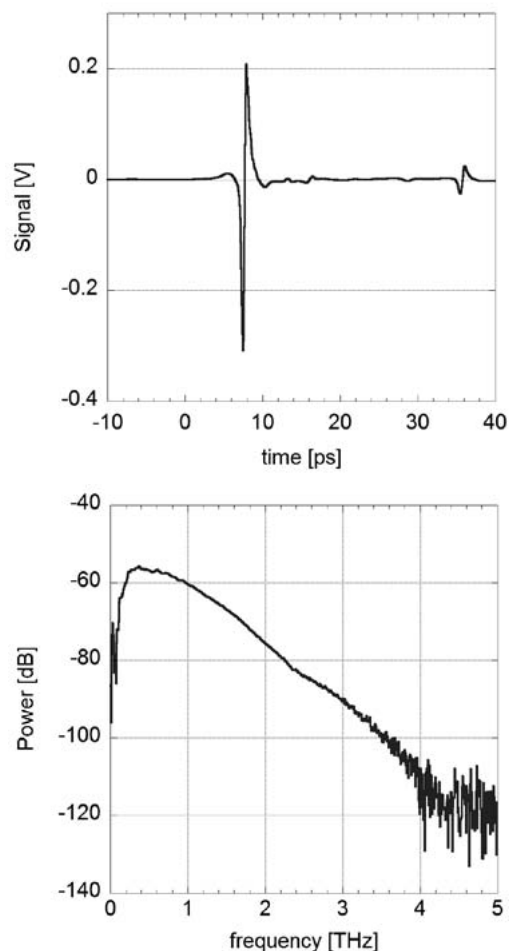


Fig. 1. Waveform (top) and frequency spectrum (bottom) of THz pulse signal.

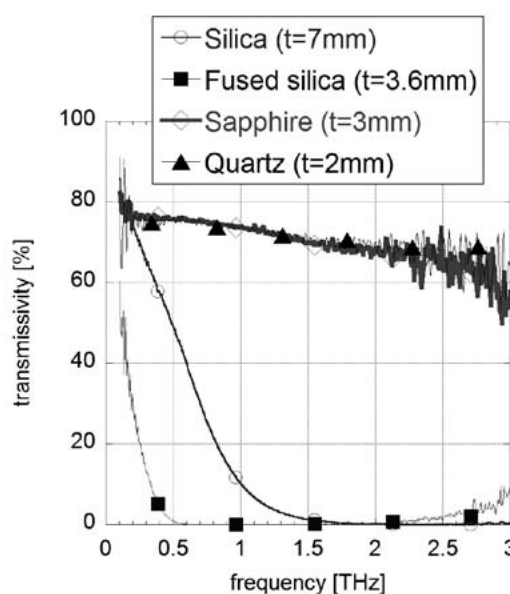


Fig. 2. Frequency spectra of window material in THz regime