Investigation of impurity transport is a key issue for better performance of toroidal plasmas. Recently an AXUV (absolute extreme ultraviolet) photodiode which has near theoretical quantum efficiency for a wide range of photon energies has been developed, and used for impurity diagnostics. According to this characteristic, the AXUV photodiode arrays filtered by metallic thin foils can realize a fast, low-cost and sensitive monitor of emissivity profiles of specific impurities in plasmas. In the previous studies, a narrow passband in the soft X-ray region arising from K-edges of the foil material have been used. In this study, however, we utilize bandpass characteristics of aluminum (Al) and tin (Sn) arising from L-edges in longer wavelength region (30-100 nm) for investigation of emission lines from relatively low-ionized impurities in CHS plasmas.

According to the survey of the VUV spectrum (10-110 nm) by a grazing incidence spectrometer (Shinku-Kogaku, Model JYF-306), line emissions from oxygen ions are predominant in this wavelength region. The most prominent lines are 55.5, 62.5 and 76.0 nm from low-ionized oxygen. Ultrathin metallic foils of Al and Sn are appropriate materials to filter these lines. For trial experiment, we have prepared a freestanding Al foil with 0.2 μm thickness and 10 mm diameter, whose ideal transmittance curve is illustrated by a thick solid line in Fig. 1. In order to eliminate the effect of the transmittance of high energy photons, we have prepared another multilayer foil composed of aluminum (0.15 μm), lithium fluoride (0.05 μm) and Parylene (N) resin (0.1 μm) whose transmittance curve is indicated by a broken line in Fig. 1. As shown, it is reasonable to derive emissivity in the passband of 17-84 nm by subtracting the signal measured by the reference filter.

We have designed a compact mount attached to a 114 mm flange as shown in Fig. 2 to insert the detector head deep inside the vacuum vessel. In order to change filters without breaking the vacuum, a rotatable wheel for five filters is placed within a cylindrical case facing the plasma. A pinhole of 0.4 mm diameter is placed on the backplate of the cylindrical case in front of the photodiode array. One of five filter mounts is left blank for bolometer mode in which total emissivity is monitored. An opaque metal plate is attached to another filter mount for usage as a shutter. For in-situ current-voltage conversion, a compact in-vacuum 20 channel preamplifier module (Clear-Pulse Co. Ltd., Model 8986A) is used with a fixed conversion ratio of 10^5 V/A. Vacuum compatible electronic parts are used to the extent possible. Output signals of the preamplifier are extracted through a D-sub type 25 pin feedthrough directly welded to the vacuum flange.

Though two identical modules will be installed in the upper and lower viewports for future tomographic measurements, only one module has been installed at present. A preliminary measurement has already been carried out in the plasmas sustained by NBI. After the complete preparation of the detectors, data acquisition and signal processing systems, this diagnostics will provide fast and low-cost monitoring of impurity emission lines in the VUV region, and be useful for studies of low-ionized impurity transport in helical plasmas.

References

Fig. 1. Transmittance of 0.2 μm pure Al foil (thick solid line) and its reference foil (broken line) plotted against photon wavelength (log-scaled). Spectral sensitivity of AXUV photodiode is also plotted by a thin solid line.

Fig. 2. Photograph of a mounting module of AXUV photodiode array and in-vacuum amplifier.