§ 24. Diagnostic of LHD Using a Space and Time Resolving Soft X-ray Polychromator

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The electron temperature at the center of LHD plasma may be over 4 keV. Then Fe and Ti atoms, the main metal impurities in LHD, can be highly ionized as He-like or H-like. By identification of 2s-3p transitions, the He-like and H-like ions of the metal impurities can be qualitatively measured with the soft X-ray polychromator which covers a spectral range of 0.7-3 nm. For Fe impurity, 2l-3l' transitions in F-like and Li-like ions may be also detected. Our research is expected to provide basic data on transport mechanism by impurities at the plasma core.

Optical alignment of the soft X-ray polychromator had been performed using a characteristic X-ray from Aluminum atom(Al-K α, 0.834nm) as a light source up to 2001. The resolving power obtained for a 10 μm slit width was approximately 520 which was a third of the theoretical value 1500. In addition, the focusing distance from the grating was 100 mm larger than the theoretical one. This meant that the best focusing position of the image was always out of the Rowland circle.

The result above suggested that it was necessary to check the radius of curvature of the spherical grating used in the polychromator. A Foucault's test for the grating was done by using an optical bench 12m long in 2002. The measured value for the radius of curvature of the grating was 10096.9$\pm$9.2 mm, while the value given by a maker was 10331mm. A difference 234mm for the radius of curvature was found but could not explain the low resolving power and the discrepancy of the detector position from the Rowland circle.

The previous method for the optical alignment of the polychromator was based on the idea that the positions of the entrance slit and the grating were precisely given on manufacture. Instead of this, a new method for alignment was developed. The incident direction of the light was determined by using two pinholes, and then the grating was placed so as to be tangential to the incident direction. As a result, a high resolving power of 1000 was achieved at Al-k α line, and the difference of the focusing distance from the Rowland circle was within 10 mm. Figure 1 shows the high resolution spectrum of Al-k α line.

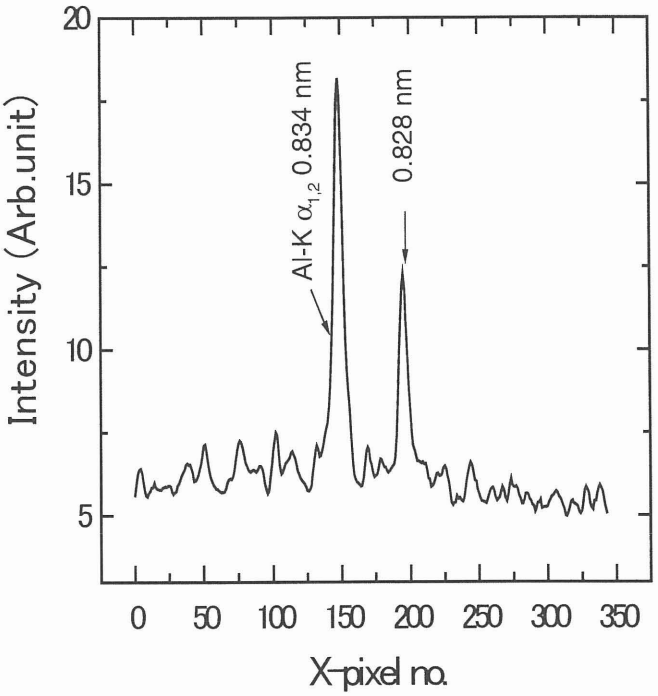

Fig. 1 Observed Al -K α line.