Development of In-situ Calibration Method by Using an IR Laser for ITER Divertor IR Thermography

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ITER divertor IR thermography (IRTh) [1] in the wavelength range of 1.5-5.0 μm is one of the diagnostic systems that Japan procures for ITER. The objective of IRTh is to measure the surface temperature (200-3600 degC) distribution of the divertor target in high time (20 μs) and spatial (3 mm) resolutions for machine protection, advanced control and physics study. The emissivity on the target material can be changed due to the change in the surface condition of the divertor target caused by depositions of impurities or erosions. Although thermocouples embedded on the side of the divertor target can be used for the calibration, the estimation of the surface temperature is difficult.

The concept of the calibration method by using an infrared (IR) laser is as follows. Before the plasma discharge (the emissivity has already known), the IR laser is injected to the divertor target in the field of view and the scattered light is observed by the IR camera. After the discharge, the scattered light of the IR laser is observed in the same way. The emissivity can be evaluated from the relation between the emissivity and the change in the scattered light intensity which has been previously obtained. Therefore, in-situ calibration method by using an IR laser has been developing in laboratory since the last year.

In the laboratory experiment, the IR camera (FLIR SC5200) which was calibrated in the wavelength range of 2.5-5.1 μm by a plane blackbody with the emissivity of 0.94 was used. For simple comparison, two tungsten samples with different surface conditions were used. One was polished to mirror surface with the surface roughness of 0.05 μm and the other was sandblasted surface with the surface roughness of 1 μm. The samples were heated by a ceramic heater in the temperature range of 190-280 degC. At first, the emissivity in each wavelength of 2.95, 3.35, 3.64, 3.80, 4.07, 4.26, 4.44 and 4.67 μm by using several band-pass filters was measured in each tungsten samples. The emissivity of the sandblasted surface was higher (0.5-0.8) than that of the mirror surface (0.05-0.4). For the sandblasted surface, the emissivity became higher as the wavelength is shorter. Secondary, the quantum cascade IR laser (DAYLIGHT solutions TLS-31032) with the wavelength of 3.3 μm was injected to the tungsten sample in the angle of 20 degree against the axis of the IR camera. The angle profile of the scattered light intensity for the sandblasted surface was broad. On the other hand, that for the mirror surface was peaked around the axis of the IR camera. Thus, the preliminary data of the relation between the emissivity and the scattered light intensity for two different surface conditions as above was obtained.

Furthermore, the experiment in higher temperature up to 1100 degC in the vacuum chamber will be performed soon in order to clarify the effect of air to IR light and to avoid the oxidation of the tungsten sample and to investigate the dependence of the emissivity on temperature. The samples in the different surface roughness (0.01, 0.8, 3.2, 9.6, 16, 32 μm) will be used and the relation between the emissivity and the surface roughness will be investigated. In the congress, we will discuss the in-situ calibration method for IRTh and show the recent results of the laboratory experiment.

[1] M. Takeuchi *et al*., Plasma and Fusion Research **8**, pp.2402147 1 - 5 (2013)