ITER divertor infrared (IR) thermography is a diagnostic system for the measurement of a surface temperature profile in the temperature range of 200 °C - 3600 °C on the tungsten divertor targets by the observed IR light with the wavelength range of 1.5 μm - 5 μm. One of the important issues is that the emissivity change of the divertor targets due to depositions, erosions and a re-crystallization affects the temperature measurement which is required the accuracy of 10 %. Furthermore, the emissivity also changes due to the dependences on the temperature, wavelength and surface roughness. Therefore, the purpose of this study is to clarify the emissivity dependence of the tungsten sample in the ITER-grade and to develop an in-situ calibration method of the emissivity. We investigated the emissivity dependence and the availability of the in-situ calibration method under 1000 °C by the laboratory experiments using an IR camera and an IR laser.

The two main results are shown. First, the emissivity was evaluated in a vacuum chamber by heating the tungsten sample with the surface roughness of 0.3 μm, 1.0 μm, 2.3 μm and 5.9 μm. The emissivity had a strong dependence on the surface roughness, whereas the emissivity changed less than 10 % in the ranges of both wavelength of 3 μm - 5 μm and temperature of 400 °C - 1000 °C. Thus, the measurement accuracy in 400 °C - 1000 °C could be satisfied by the temperature derivation from the ratio of the IR lights in two wavelength bands. Secondly, the angular distributions of the scattered light of the IR laser irradiated from the angle of 5° against to the line of sight of the IR camera were measured by changing the normal angle of the tungsten sample from -55° to 75° to the line of sight of the IR camera because the observed divertor target is inclined to from -60° to -20° in ITER. In the case of the surface roughness of 0.3 μm, the scattered light was not observed in the irradiation angle of ITER. In the case of the surface roughness of 1.0 μm, 2.3 μm and 5.9 μm, the scattered lights were observed and the angular distribution of the scattered light became broader as the surface roughness was larger. Therefore, the emissivity could be calibrated in the irradiation angle of ITER in the condition that the surface roughness is more than 1.0 μm.