§13. Thermal Characteristics of Foils for Imaging Bolometer

Hino, T., Sano, R., Yamauchi, Y. (Hokkaido Univ.), Peterson, B.J.

An IR imaging video bolometer is a measuring instrument for plasma radiation. The performance of an imaging bolometer is dependent on the thermal characteristic and photon absorptive property of the bolometer foil[1-2]. We measured the thermal characteristics of foils that have different materials, thicknesses and surface conditions in order to find the bolometer foil material which has the best sensitivity and time resolution[3]. We irradiated the foils with a He-Ne laser and measured the change in temperature distribution with an IR camera. As for foil materials, W, Ta, Au and Pt, were employed. Foils were blackened either on both sides or on one side by carbon in order to improve the IR emissivity for the IR camera measurement and to increase the absorption of the He-Ne laser. The thickness of the foils ranged from less than 1 to 10μm depending on the material. Fig.1 shows Ta foil mounted in copper gasket.

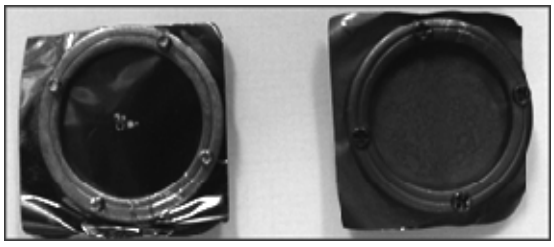

Fig.1 10μm Tantalum foil mounted in copper gasket.

Fig. 2 shows a typical thermal response of the foil for the laser irradiation. From this data, the temperature rise, $\triangle T$, and the decay time, τ_{ave}, were obtained for the foils of W, Ta, Au and Pt. The sensitivity is proportional to the value of $\triangle T / \tau_{av}$.

Fig. 3 shows the value of $\triangle T / \tau_{ave}$ against the detectable photon energy. The foils have different thicknesses. The detectable photon energy is proportional to the thickness of the foil. The detectable energy was calculated for each foil.

Pt had the shortest time constant for the temperature rise/decay and Ta had the largest temperature rise among foils with the same thickness except Au. In consideration of the attenuation thickness versus photon energy of each material, the Pt foil is the most suitable for the bolometer among the evaluated materials.

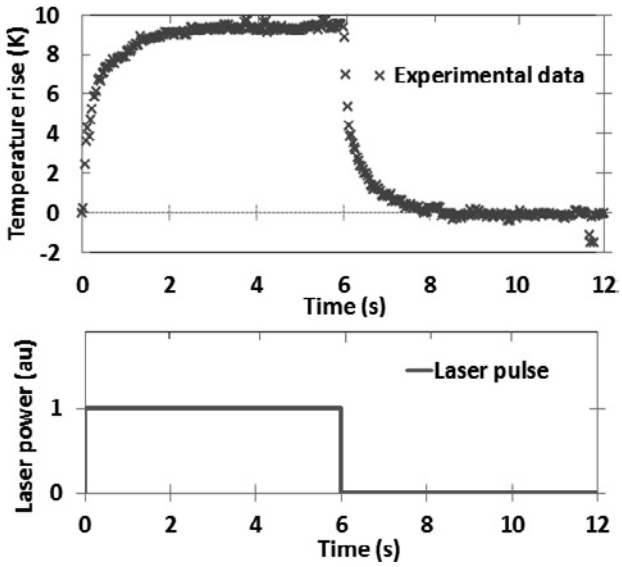

Fig.2 Temperature rise and decay of metal foil.

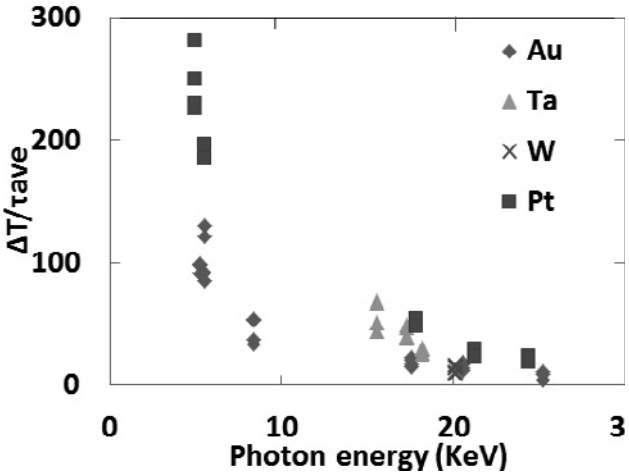

Fig. 3 Sensitivity of metal ($\triangle T/\tau_{ave}$) vs detectable highest photon energy.

1) B.J. Peterson *et al.,* Rev. Sci. Instrum. **74(3)** (2003) 2040
2) B.J. Peterson *et al.*, Fusion Sci. Tech. **58 (1)**(2010) 412
3) R. Sano *et al*, Accepted for Plasma and Fusion Research, Special Issue of ITC 2010