Comparison of Sensitivity of Au and Pt Foils for the Imaging Bolometer for KSTAR

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As part the Japan-Korea cooperation program in magnetic fusion research, bolometer diagnostics are being developed for the KSTAR experiment as a collaboration between the National Institute for Fusion Science and the National Fusion Research Center (Rep. of Korea). This collaboration involves the development of both resistive bolometer arrays and InfraRed imaging Video Bolometers (IRVB) for the KSTAR experiment. The IRVB is planned to be installed in 2010 in preparation for the third experimental campaign on KSTAR.

The IRVB is a fusion reactor relevant diagnostic for the measurement of radiated power [1, 2]. Essential to its ability to make accurate temporally and spatially resolved measurements of radiated power is the detailed calibration of the thin metal foil that converts the radiated power to infrared radiation measured by an IR camera. The choice of the foil material is critical to optimizing the sensitivity of the imaging bolometer. Calibration of the foil provides information on the actual sensitivity of the foil which can help in selecting the best foil material. In this work thermal properties of the 0.63 micron thick Au and 0.87 micron thick Pt foils (see Fig. 1) are

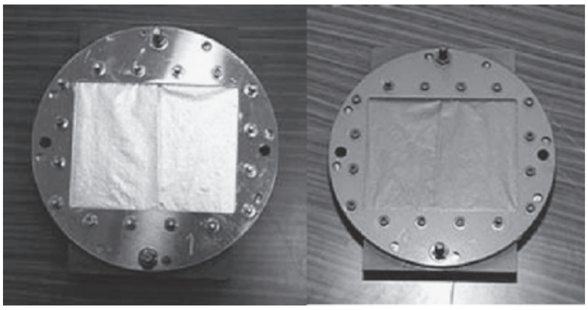

Fig.1 Platinum foil mounted in copper frame before (left) and after (right) blackening with graphite.

investigated by heating the foils with a chopped 25 mW HeNe laser and observing the temperature change, ΔT, of the foil and the rise/decay times, $\tau_{rise/decay}$, of the foil temperature in 1 cm intervals across one quadrant of the foil. For a foil in which the cooling is dominated by diffusion, since the sensitivity of the foils is proportional to the ratio of the thermal diffusivity to the thermal conductivity of the foil, κ/k, which is proportional $\Delta T/\tau$, where τ is the average of the decay and rise times, we can compare the relative sensitivities of the foils by comparing these ratios for Pt and Au foils. The results surprisingly indicate that Pt is more than 9 times more sensitive than Au even though standard thermal properties indicate that Au should be 14% more sensitive than Pt. This inconsistency is largely due to a slightly smaller decay time, τ, which is inconsistent with a 5 times smaller κ, in the case of the Pt compared to Au. While the 5 -6 times larger temperature rise, ΔT (see Fig. 2), is somewhat consistent with 3.2 times smaller kt for the Pt foil compared to Au foil. This inconsistency in the thermal times, along with observed differences between the rise and decay times, indicate that the IR radiation is dominant over diffusion in the cooling of the foil. This is also supported by observations of the distributions of this parameters across the foils. In that case the sensitivity should be evaluated by $1/k \sim \Delta T$ which indicates that Pt is 8 times more sensitive than Au, while the ratio of thermal conductivities indicates that it should be only 4 times more sensitive.

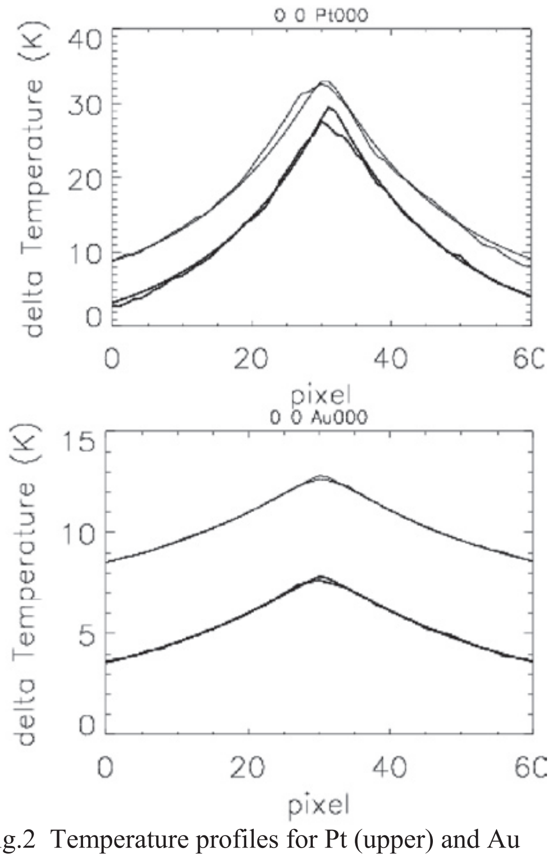

Fig.2 Temperature profiles for Pt (upper) and Au (lower) foils. In each plot upper profile is vertical profile and is offset by 5 C and lower profile is horizontal profile. Fits to a modified two-dimensional Gaussian are also shown.

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1)B.J. Peterson, Rev. Sci. Instrum. **74** (2000) 3696.
2) B. J. Peterson et al., Rev. Sci. Instrum. **74** (2003) 2040.