# §20. Comparison of Thermal Conductivity of Au and Ta Foils for an Imaging Bolometer

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Accurate calibration of the imaging bolometer is essential to provide reliable measurements of radiated power [1,2]. In addition, characterization of prospective foil materials is necessary in order to select the most sensitive foil material. The noise equivalent power density, $S_{IRVB}$, (the inverse of the sensitivity) of the InfraRed imaging Video Bolometer (IRVB) is simplified from Equation 10 in Ref. 1 as

$$S_{IRVB} = \frac{\sigma_{IR}}{\sqrt{f_{IR} N_{IR}}} \frac{k t_f}{\kappa} \sqrt{2 N_{bol} f_{bol}^3}$$

for temperatures below 1000 C and $5\kappa^2 N_{bol}^2 < f_{bol}^2 A_f^2$ where the first product term describes the sensitivity in terms of the IR camera parameters; noise equivalent temperature, $\sigma_{IR}$, frame rate, $f_{IR}$, and number of pixels, $N_{IR}$, the second product term the foil parameters; thickness, $t_f$, thermal conductivity, $k$, and thermal diffusivity, $\kappa$, and the third product term the IRVB parameters; number of channels, $N_{bol}$, and frequency resolution, $f_{bol}$. In terms of the foil properties the nominal values of k and κ/k (sensitivity) are given in Table 1 for various candidate foil materials. From this equation it can be seen that the sensitivity is inversely proportional to the $k\ t_f$ product. According to the nominal values $\kappa/k$ Ta should be nore sensitive than Au, but the result of a laser calibration shown in Figure 1 a and b show that the measured value of $k\ t_f$ for Ta is more than 2 times greater than the nominal value which lowers the sensitivity of the foil by a factor of over 2. However the Au foil shows measured values that are closer to the nominal value (Fig. 1 c and d), but the variation across the foil (comparing Fig. 1 c and d) is strong compared to the uniformity observed in the Ta foil(comparing Fig. 1 a and b).

| | Tensile strength (MPa) | $\sigma_{neutron}$ (Barns) | $k$ (W/m K ) @0-100C | $\kappa/k$ (cm$^3$ K/J ) | $E_{ph}$ (keV) @10μm |
|---|---|---|---|---|---|
| Hf | 745 | 103 | 23.0 | 0.52 | 18.4 |
| Ta | 760 | 22 | 57.5 | 0.43 | 20.1 |
| Au | 220 | 98.8 | 318 | 0.40 | 23.2 |
| W | 1920 | 18.5 | 173 | 0.39 | 21.4 |
| Pt | 200-300 | 9.0 | 71.6 | 0.35 | 23.9 |

Table 1. parameters of various IRVB foil candidate materials.

1)B. J. Peterson et al., Rev. Sci. Instrum. **74** (2003) 2040.
2)H. Parchamy et al., Rev. Sci. Instrum. **77** (2006) 10E515.

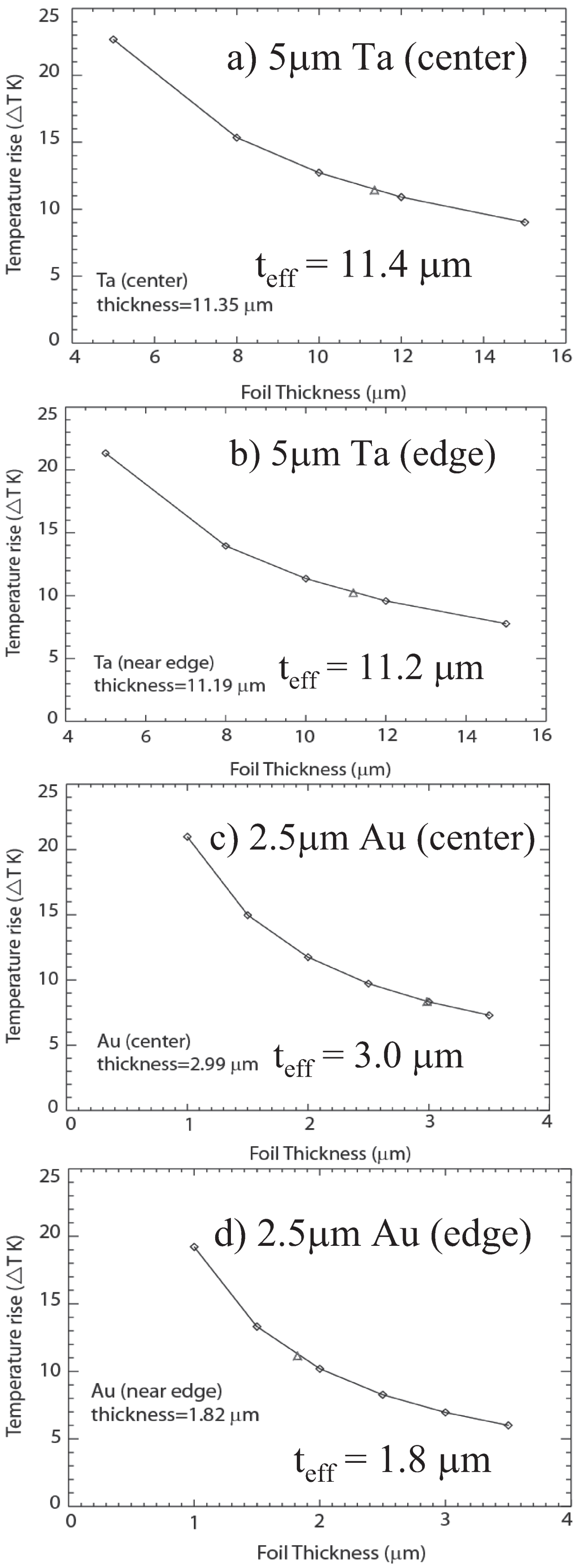


Fig. 1. Temperature rise of foil due to HeNe laser from finite element model (diamonds) and measurement (triangle) versus foil thickness ($kt_f$) at center (a) and edge (b) of 5 micron Ta foil and 2.5 micron Au foil center (c) and edge (d).