§30. Improved Calibration Technique for the IRVB

Drapiko, E.A., Peterson, B.J.

The earlier developed technique[1] based on using of the Ne-He laser to illuminate spots on a foil with 1 cm steps showed some issues. The foil was fixed and mounted inside the vacuum vessel while the IR camera and laser were outside. So the IR camera and laser beam were moved to provide coverage of the 9 by 7 cm foil. Such an approach showed high laser power nonuniformity on the foil inside the chamber due to vacuum window transition nonuniformity. In addition final analysis consists of solving huge amount of FEMs for every foil parameter. Also, a limited field of view of the IR camera with a fixed foil requires making the calibration by quadrants and venting the chamber four times during the calibration. To avoid the above mentioned problems a new calibration technique using a movable foil and UV LEDs mounted inside the vacuum vessel was developed.

In order to simplify the routine operation of foil calibration we have designed a new setup using the NI Labview controlled stepping motors for foil movement, camera acquisition trigger and LED pulse trigger. The NS375M-SFHM LED by Nitride Semiconductors was used. This is a high power UV module which consists of four 375 nm wavelength UV LEDs with 5.3 mm spacing, providing 450 mW of power. Such a spacing gives four clear temperature peaks, so four local characteristics on a foil could be determined from a one measurement. The module was placed as close as possible (about 0.5 mm) to the foil thus some corner parts of the foil was not reachable. The moving table allows calibration of foils up to 10 by 13 cm with up to 1 mm steps. 3 mm pinholes were set in front of each LED in the module to collimate the beam and provide clear peaks on a foil with slightly reduced power.

We were making a sequence of different width pulses with a 100 ms period. Right at the beginning and at the end of the pulse we trigger the IR camera to grab one image. Thus subtracting the image taken at the beginning of the pulse from the image at the end we can obtain the differential measurements of energy.

The FLIR SC4000 IR camera was used. This camera can provide 320x256 pixels images at 420 frames per second rate. Also it works with an external trigger which was important for that experiment, because we have to grab the image exactly at the beginning and at the end of LEDs pulses. The main point of the experiment was to determine the specific thermal capacity. The idea was to avoid using FEMs in calibration procedure and make it less time consuming. So specific thermal capacity per unit area

$$c_s = c_v t_f\,, \qquad (1)$$

where c_v is the volumetric thermal capacity and t_f is the of thickness, could be measured directly using following equation

$$c_s = \frac{e_{abs}(x,y)}{\Delta T(x,y)}\,, \qquad (2)$$

where e_{ebs} – absorbed energy. For an unknown profile

$$c_s = \frac{\overline{E_{abs}}}{A_{abs}\,\Delta T(x,y)}\,, \qquad (3)$$

where A_{abs} – area of averaging. In addition knowing the c_v for platinum we can determine the local foil thickness from Equation 1. Thus, the only foil parameter which needs FEMs to be defined is the specific thermal conductivity. Figure 1 shows the subtracted frames for 8 ms LED's pulse at two different locations on the foil.

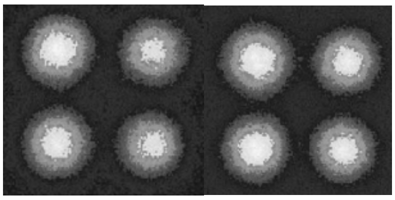

Fig. 1. Foil calibration results

The same pictures ware acquired for 2,4 and 6 ms pulse width to check the linearity.

Table 1 shows the calculated thicknesses map for the foil

1.132983	1.417552
1.340046	1.333685
1.228959	1.476075
1.413709	1.41713

Table 1.

[1] B.J. Peterson, A. Yu. Kostrioukov, N. Ashikawa, M. Osakabe, and S. Sudo, RSI **74** N3 (2003).