**Thermal cycling of prototype bolometer sensors for ITER**

Sina Jahanbakhsh1,a, Hans Meister1, Christian Ingesson2 and Ulrich Walach2

*1 Max Planck Institute for Plasma Physics (IPP), Boltzmannstr. 2, 85748 Garching, Germany*

*2 Fusion for Energy (F4E), C/ Josep Pla 2, Torres Diagonal Litoral B3, 08019 Barcelona, Spain*

a) Email: [sina.jahanbakhsh@ipp.mpg.de](mailto:sina.jahanbakhsh@ipp.mpg.de)

In order to evaluate endurance and compatibility of the prototype bolometer sensors to ITER relevant environment, various tests are being conducted on the sensors. The prototype sensors include two different sensor types, namely self-supporting substrate (Au absorbers on 20-μm thick yttria-stabilized ZrO2 (YSZ) substrates - Pt meanders and tracks) and supported membrane (Au absorbers on 3 μm thick SiN membranes supported by a Si frames - Pt meanders and tracks). The results for calibration of the sensors at temperatures up to 325 °C were presented in a previous contribution [1].

The aim of the current study was to investigate the effect of several thermal cycles on the prototype bolometer sensors. In addition, the failure statistics obtained will contribute to determining the adequacy of the sensors for the use in ITER. The main objectives were mechanical stability of the sensors and also potential changes of sensor calibration parameters due to thermal cycles. In each thermal cycle the sensors were calibrated before starting the heating, and then were heated with a rate of 2.5 K/min up to 350 °C. The sensors were kept for 20 minutes at this temperature, then the setup was cooled down overnight. This was repeated 19 times. Additional 5 cycles up to 400 °C were done by manufacturers.

From eight supported-membrane sensor channels, seven survived till end of the test. One channel lost its electrical connection during the 9th cycle. There was a significant increase in meander resistances of all channels in the first five cycles. The total increase of the resistances was approximately 30 percent. The calibration parameters of the sensors with heat conduction layer (HCL) also changed considerably during thermal cycling. This was not observed in the sensor without HCL.

The self-supporting sensor, which was put inside a sensor holder and calibrated during the test, survived only nine cycles; although material of the holder (Al2O3) was chosen so that its thermal expansion coefficient was close to sensor substrate. The significant resistance increase was also observed in this sensor. This sensor had an HCL and the sensor parameters were changed by thermal cycling. The self-supported membrane sensors, which were put inside the vacuum chamber without a sensor holder and thus it was not possible to calibrate them during the test, survived the tests. This indicates the importance of the optimization of the sensor holders for this type of bolometer sensors.

References

[1] Jahanbakhsh, S. *et al.*, “Calibration and evaluation of prototype bolometer sensors for ITER,” 32nd Symposium on Fusion Technology (SOFT), September 19-23, 2022, Dubrovnic, Croatia.