Calibration of Ophir Terahertz Sensors

Terahertz (THz) applications - till recently mainly still in the R&D phase - are beginning to emerge into the light of the commercial and industrial day. So is the need to measure these THz beams.

Ophir offers several solutions for THz measurement, including sensors for measuring low powers (down to nanowatts), high powers (up to 3W), as well as profiling THz beams. Let's have a look at how we calibrate the 3A-P-THz and RM9-THz sensors

3A-P-THz

The 3A-P-THz is a variation of our standard 3A-P sensor but with a special absorber using neutral density glass that has very uniform properties from batch to batch. Thus if we produce an absorption curve including the terahertz (THz) spectral region for particular sample of the absorber, we can use this curve to calibrate the sensors over the entire THz region.

Ophir has measured the absorption of the absorber over various THz spectral regions at leading laboratories involved in THz research including the Rensselaer Polytechnic Institute (RPI), Ariel University and the PTB national laboratory in Germany. The measurements are shown below

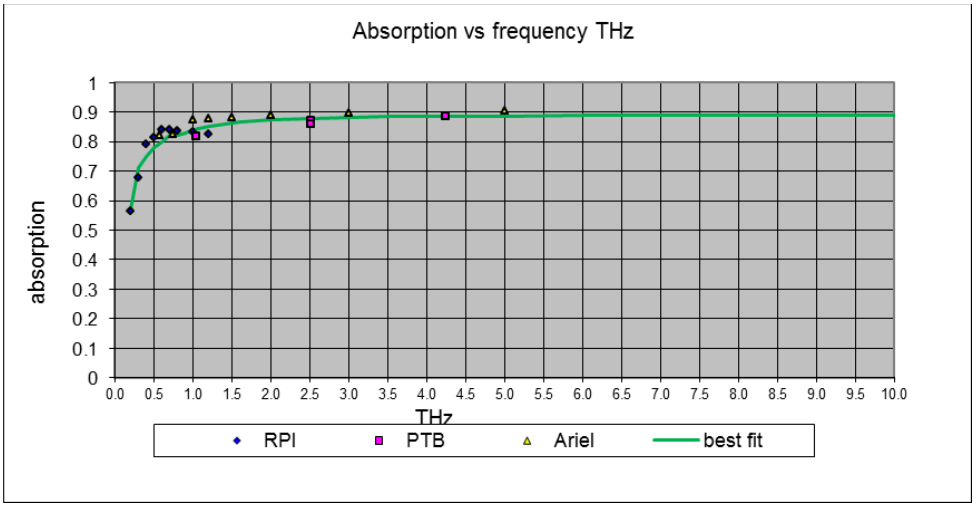

Figure 1. Absorption spectra of 3A-P-THz

Since the precise absorption of this absorber is known at 532nm, we can use a 532nm laser to calibrate the device and enter correction factors based on the measured absorption in the various THz regions to accurately calibrate for the THz

region. The uncertainties given in our specs are the sum total of uncertainties in the 532nm calibration and the uncertainties in the RPT, Ariel and PTB absorption measurements.

RM9-THz

The RM9-THz is a variation of our very sensitive RM9 sensor series with lock in amplifier and has a special absorber surface that absorbs much more than typical absorbers in the THz region. Other absorbers absorb on the order of 10% or less but the Ophir absorber absorbs from 25% to 75% thus making meaningful calibration possible. Once we know the absorption in the visible (about 98%) and the absorbance at THz frequencies, then we can calibrate the sensor for THz frequencies.

Various samples of the sensor absorber have been sent to the PTB national lab in Germany to be calibrated at 5 different frequencies between 0.76 and 4.25THz. A number of samples of the same absorber have been measured by a spectrometer at the University of California, San Diego (UCSD). Similar to the 3A-P-THz above, the sensor is calibrated at 532nm where we know the absorption and the sensitivity is adjusted for various THz regions from the measured absorption in those regions. The uncertainties given in our spec are the sum total of the uncertainties in the PTB measurement, the variations in absorption between different absorbers and the uncertainties in the UCSD measurements. The solid line in the absorption graph below is based on these laboratory measurements. The dotted line is a reasonable extrapolation based on the trend in the measured region.

Thus the Ophir RM9-THz has a **meaningful response** throughout the range 0.1 – 30 THz; it is **calibrated** over the range 0.7 - 10 THz, with PTB-traceable absolute calibration accuracy stated in the spec.

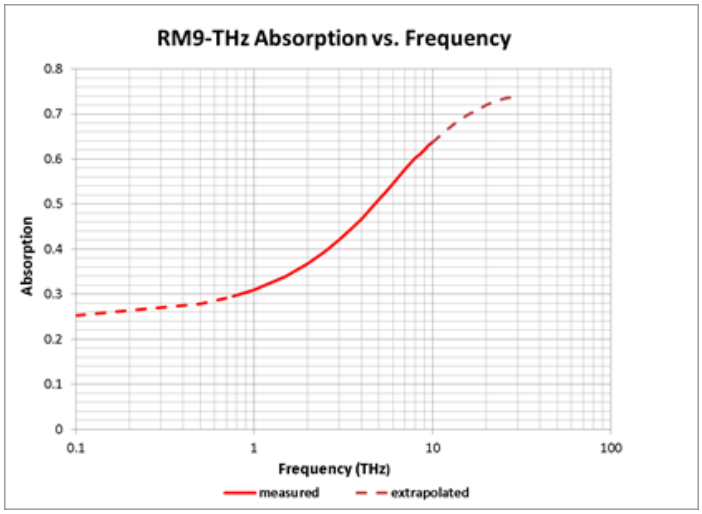

Figure 2. Absorption spectra of RM9-THz