MPROBE™ Measurement of Photoresist

Photoresist is used in many applications. The type, the thickness of photoresist (PR) and substrate it is deposited on can be different.
In most cases, it is necessary to measure the thickness of the PR to control the process.
MProbe™ Vis reflectometer (400nm -1000nm wavelength range, thickness range: 10 nm -50μm) can be successfully used for this measurement. Illumination wavelength range is, typically, limited using a long pass filter (LP500) to avoid PR exposure. Final wavelength range (with LP500 filter): 500-1000nm.
MProbe™ Vis MSP is used for a small spot measurement.

In this note we discuss several different applications of the PR:
1. Thin PR on the glass substrate (master CD/DVD application)
2. Thin PMMA on Sapphire wafer
3. PR on Si (microspot)
4. PR on Si (blanket wafer)
5. PR on copper (printed board)

I. Thin PR on the glass substrate.

This application is used for master CD/DVD and other recoding applications. Glass disk was spin-coated with Microposit S1800 series (Shipley). Cauchy coefficients of the PR were provided by the manufacturer. However, PR has small absorption in the 500nm - 600nm range that was directly measured along with the thickness. Optical constants of the PR were represented using CauchyK model where only absorption (k) part was measured, while n coefficients were fixed.

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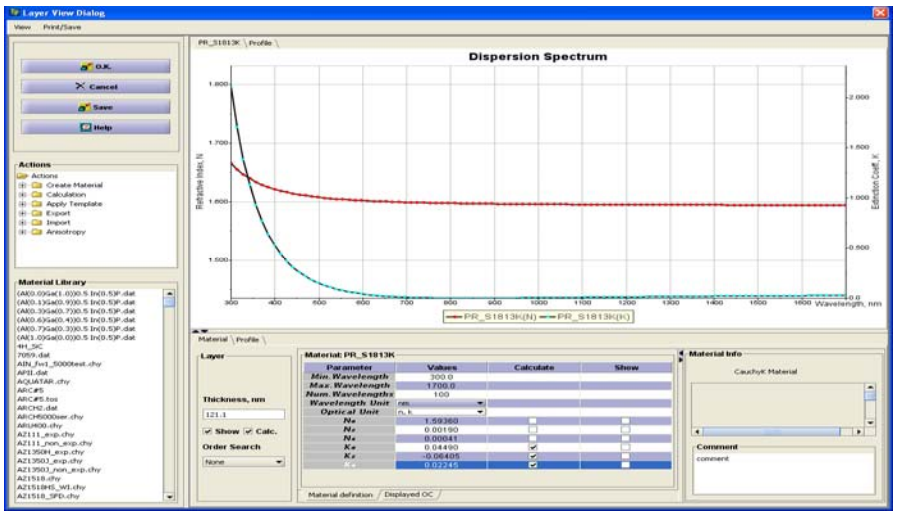

Fig.1 Optical constants of the PR, k is measured, n was provided by manufacturer.

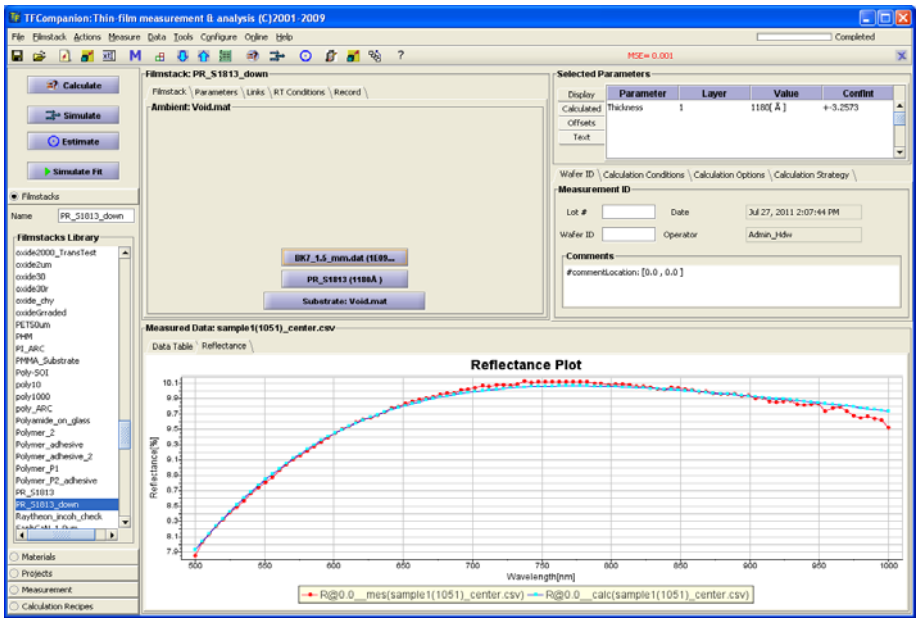

Fig. 2 Results of the PR measurement. Measured parameters are thickness (118nm) and absorption (see Fig. 1)

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II. PMMA on Si wafer

PMMA 950 (MicroChem) was spin coated on Si wafer. Optical dispersion of the PMMA material (Cauchy coefficients) was provided by manufacturer. MProbe Vis was used to measure the thickness of the coating.

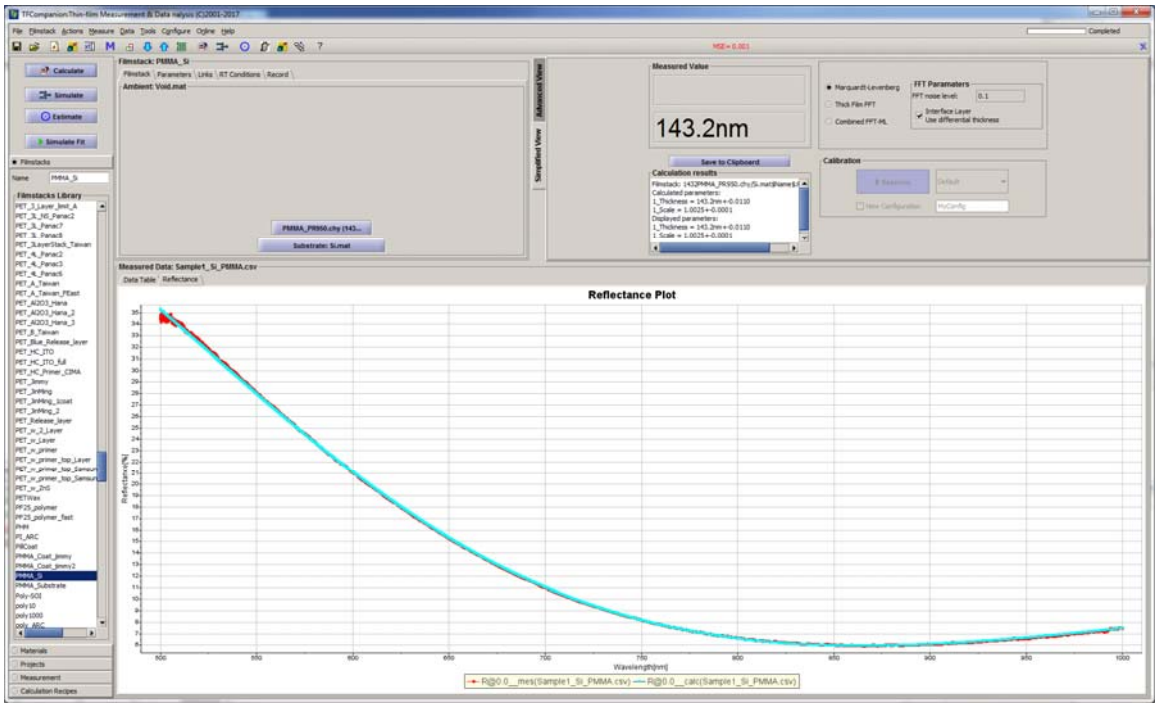

Fig. 3 Measurement of the PMMA: measured data vs. model. Thickness: 143.2nm

III. Photoresist on Si

PR was spin-coated on Si wafer and measured using MProbe MSP Vis system (using a 20µm measurement spot). Refractive index of the PR was not known exactly. Optical constants of the PR were represented using CauchyK approximation – both n & k were measured along with the thickness

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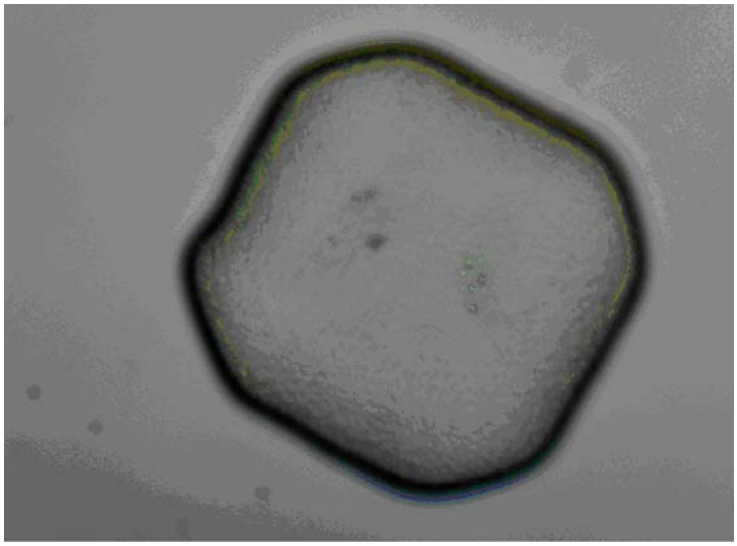
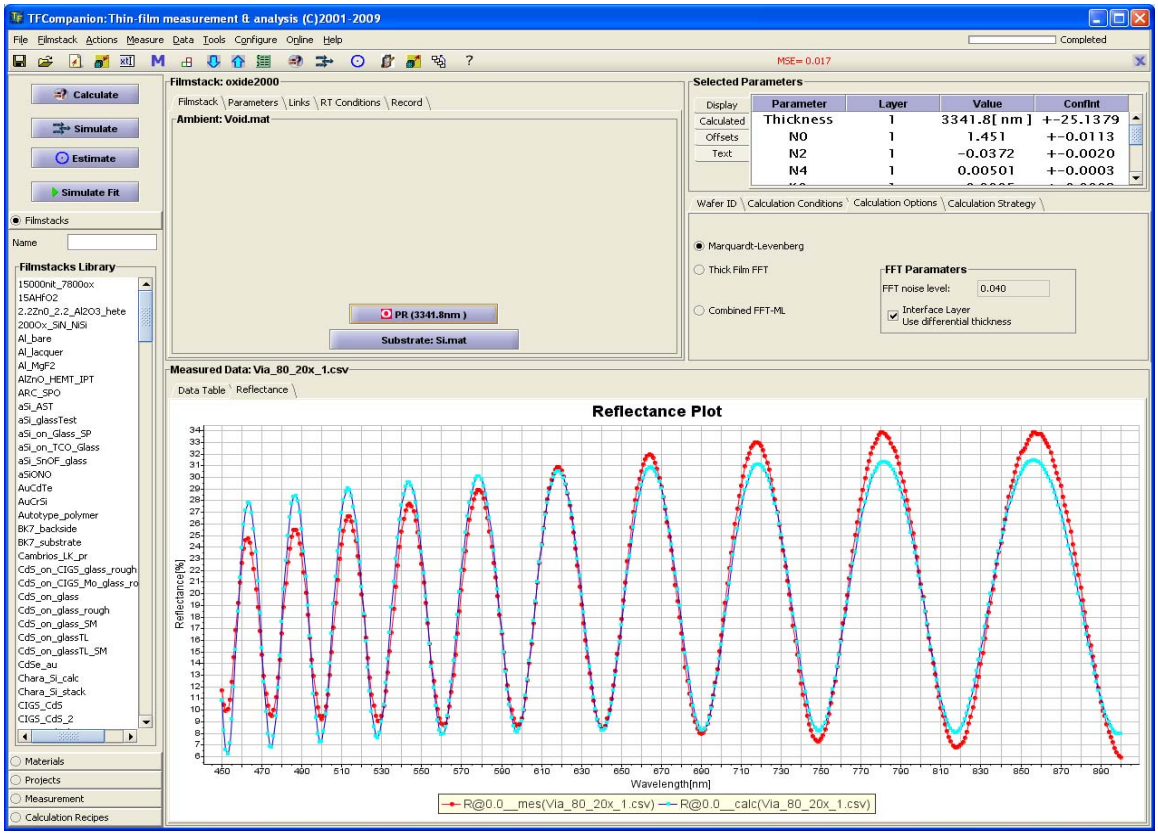


Fig. 4. Photoresist dot (15 x15 µm) on Si wafer



Fig, 5 Measurement results: fit of model to measured data. Thickness: 3341nm

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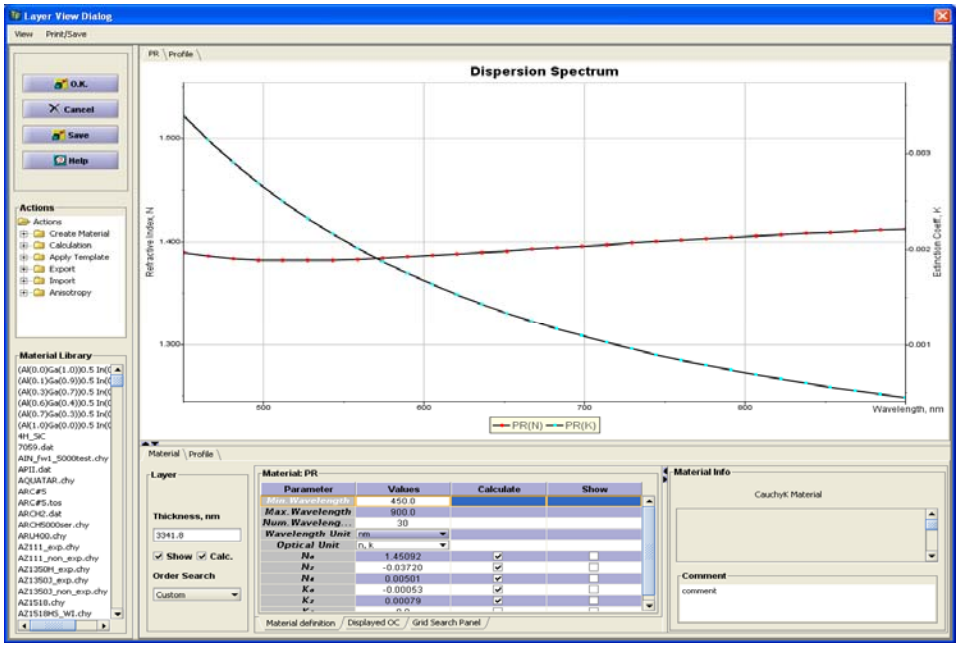

Fig. 6 Measured n & k of the Photoresist

IV. Photoresist on Sapphire wafer.

To accurately determine the R.I. dispersion of the PR, we first use direct curve fitting and measure following parameters:

1. Thickness of the PR
2. R.I. dispersion of the PR. Directly measured parameters are Cauchy coefficients, since dispersion is represented using Cauchy approximation.
3. Surface roughness correction and scale. These parameters correct for variation of the distance to sample and residual backside reflection/scattering

Once filmstack is determined – we can use FFT for measurement, to make it very easy and reliable in production environment,

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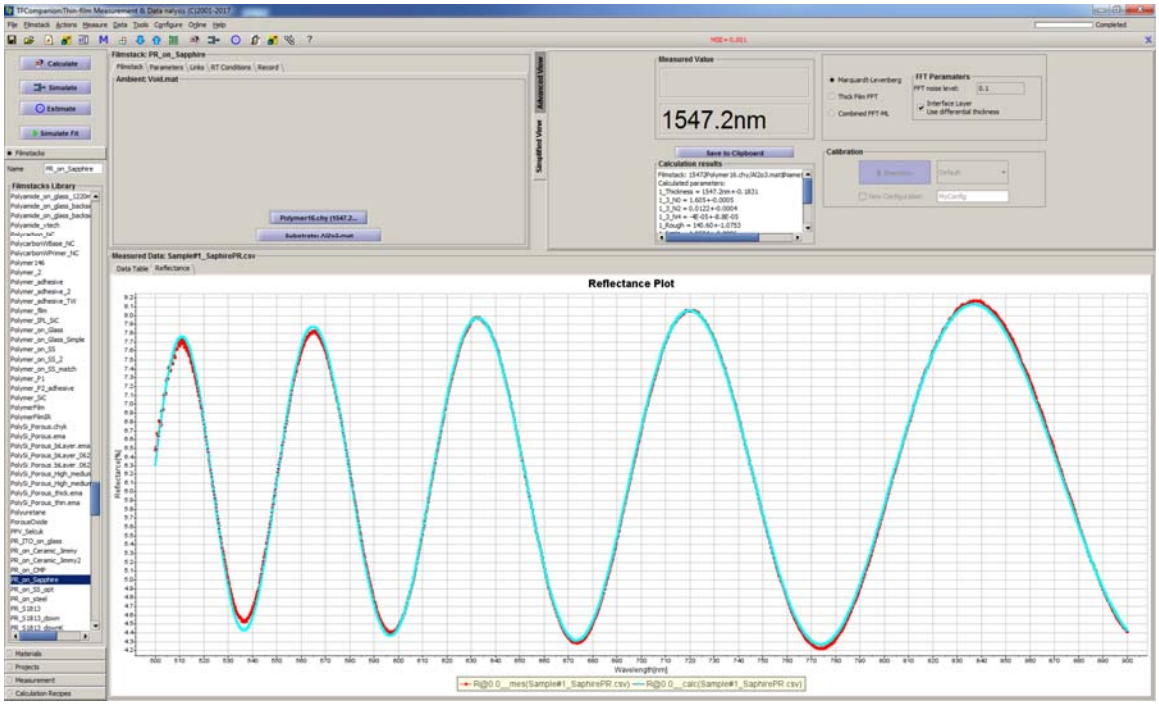

Fig. 7. PR on Sapphire. Curve fit to determine R.I. dispersion
Measured parameters: thickness, R.I. of the PR (Cauchy coefficients), surface roughness and scale.

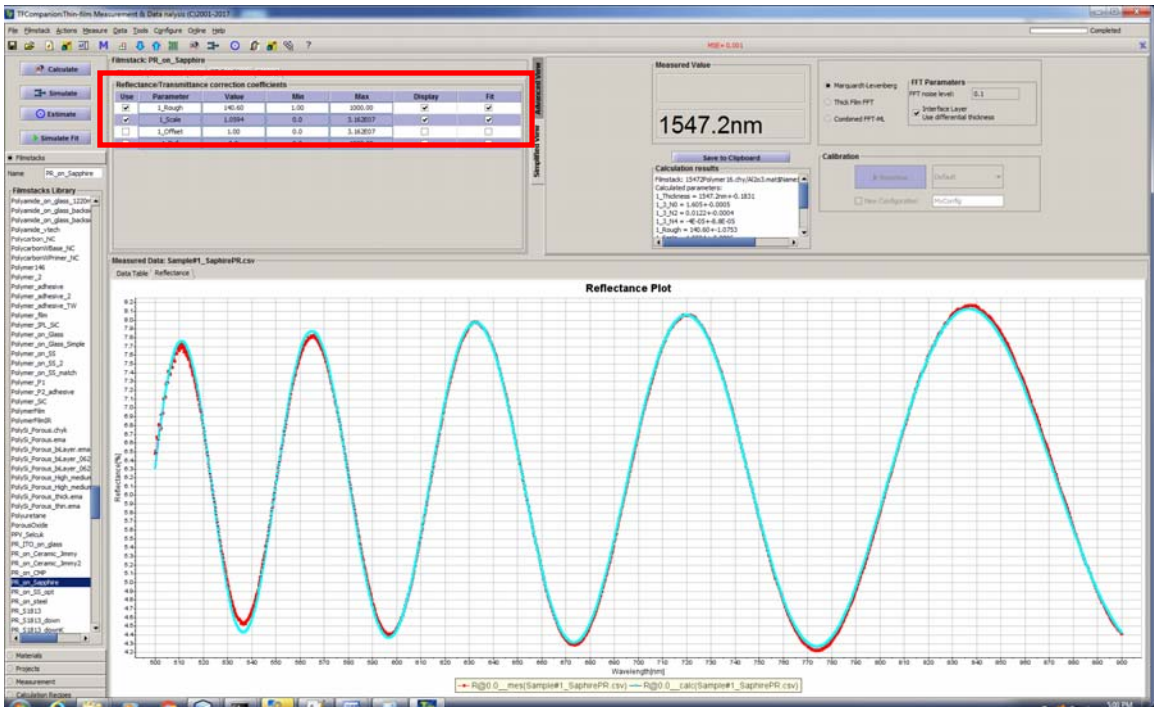

Fig. 8 Roughness and scale parameters are adjusted

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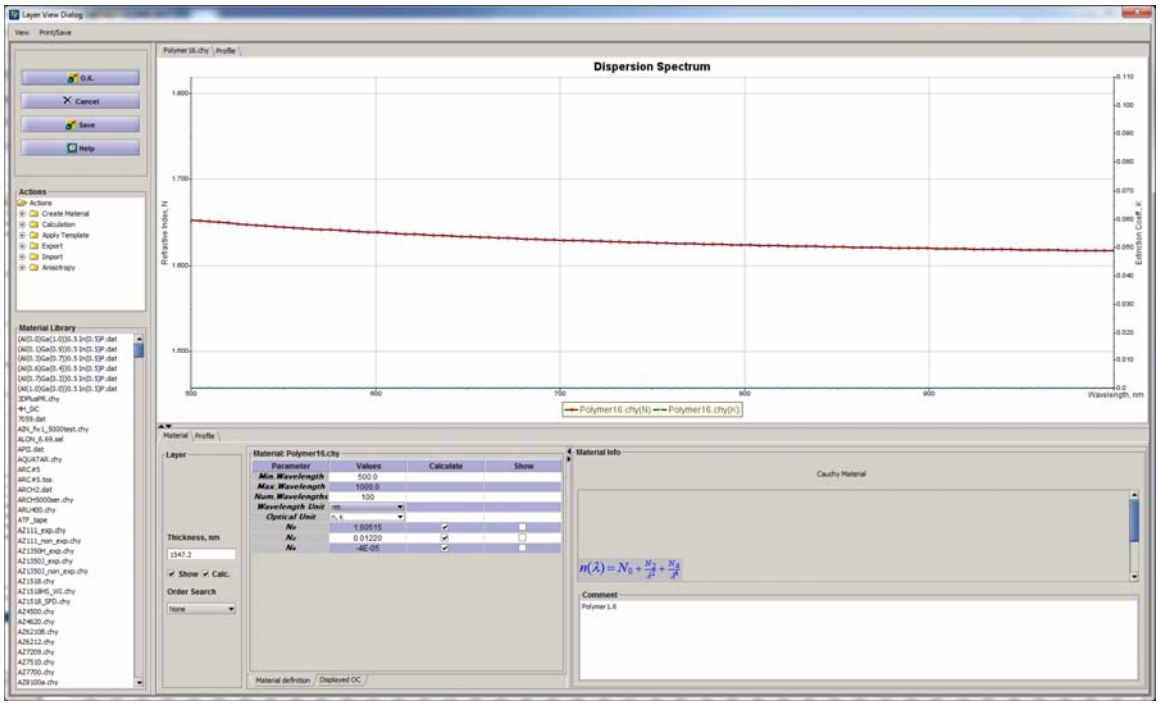

Fig. 9 Photoresist R.I. dispersion (Cauchy coefficients are measured)

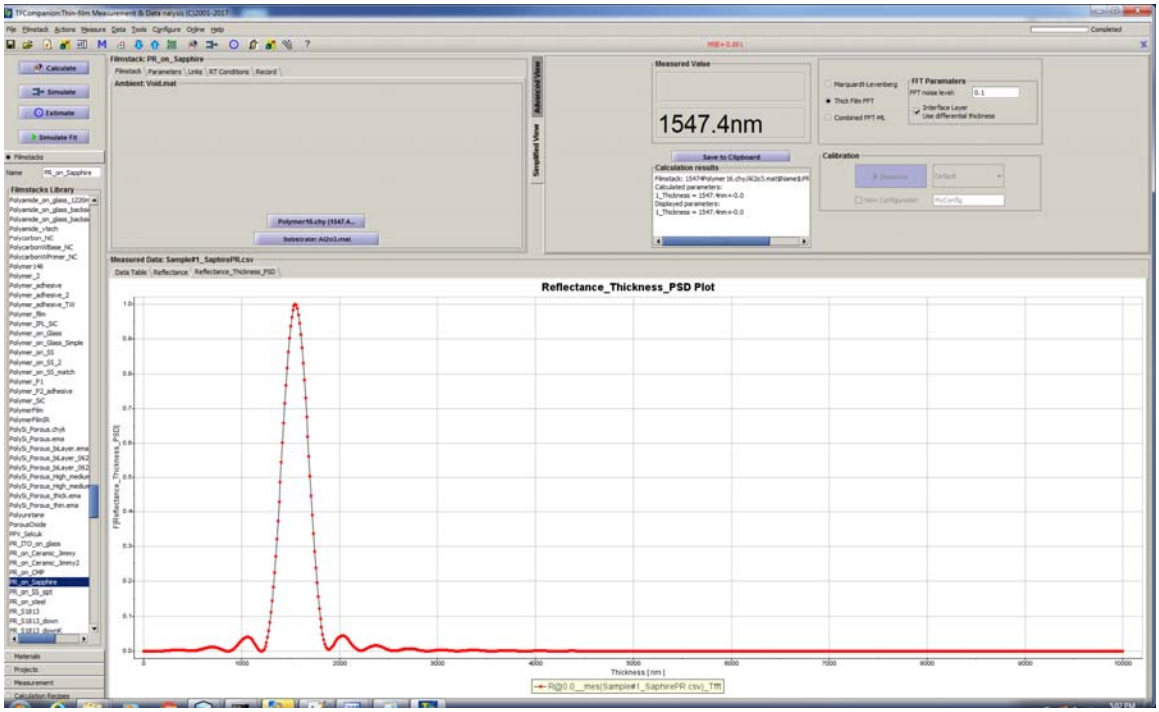

Fig. 10. Photoresist on Sapphire. Thickness is determined using FFT (filmstack developed with curve fitting -Fig.7 – is used)

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V. Photoresist on Copper (printed board)

Photoresist was deposited on a printed board (copper) and measured using MProbeVisHR system (700-1000nm). PR had refractive index n~ 1.6.
Copper surface had dense black pattern and was matted, this produced a fair amount of scattering. For this reason, we used and thick film algorithm (FFT) to determine the thickness.

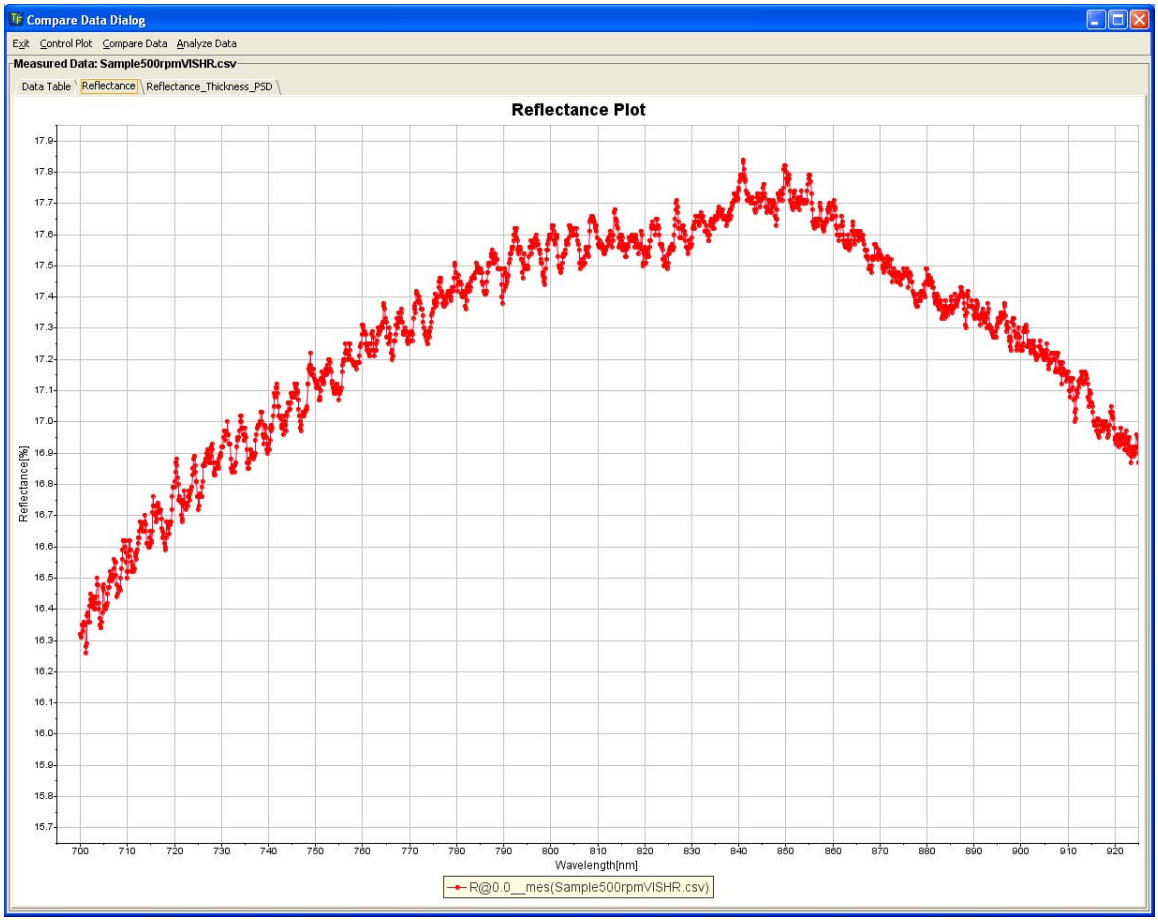

Fig. 11. Measured reflectance spectrum (zoomed portion in shown). Oscillation/fringes of ~ 0.3% of reflectance indicate the presence of the PR. Amplitude is small because of the scattering.

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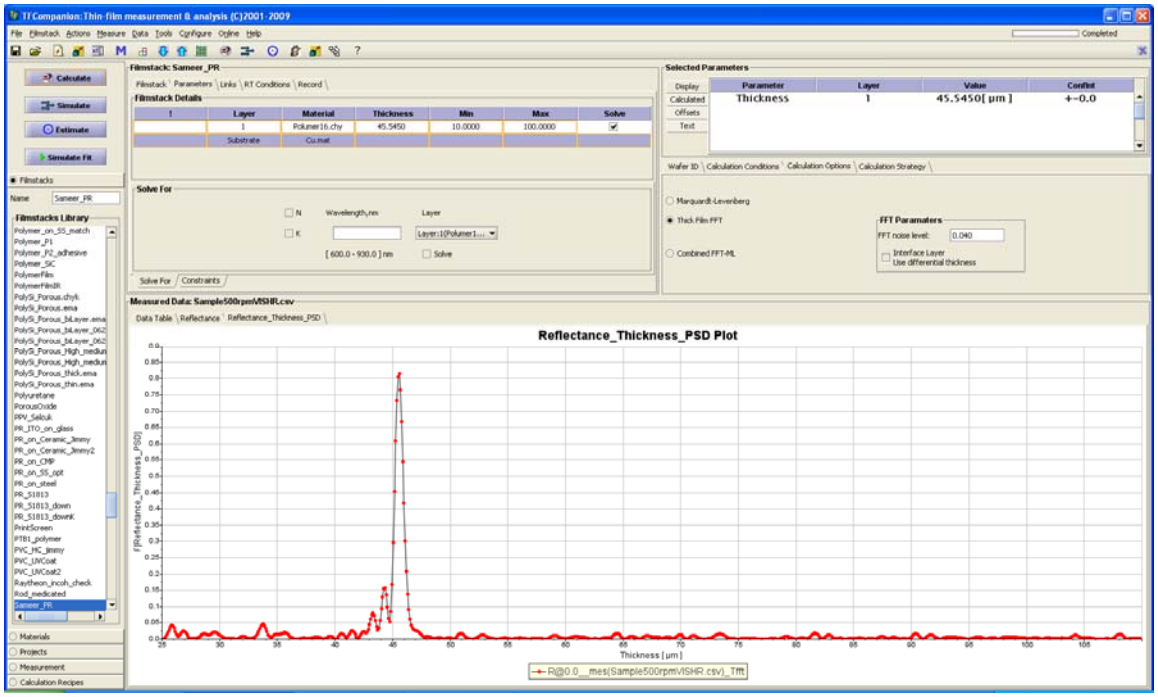

Fig. 12 Measurement of the PR on printed board. Peak indicates the thickness (45.54µm) of PR. The peak is sharp and clear despite very weak features in the spectrum.

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