Semiconsoft,Inc

Thin Film Measurement solution
Software, sensors, custom development
and integration

Thick film measurement Accuracy Improvement
New Software features

FFT based algorithm for thickness measurement is fast, convenient and, frequently, is the only viable approach for thick films measurement. But measurement accuracy using this algorithm can be lower as compared to direct curve fitting.
Some of the new features were added to improve the accuracy.

Background

The accuracy of the thickness measurement with FFT algorithm depends on how accurately the position of the peak can be determined.
The maximum error of the measurement can be determined as $(X_{n+1}-X_n)/2$, where X_n and X_{n+1} are points adjacent to a peak (Fig. 1)

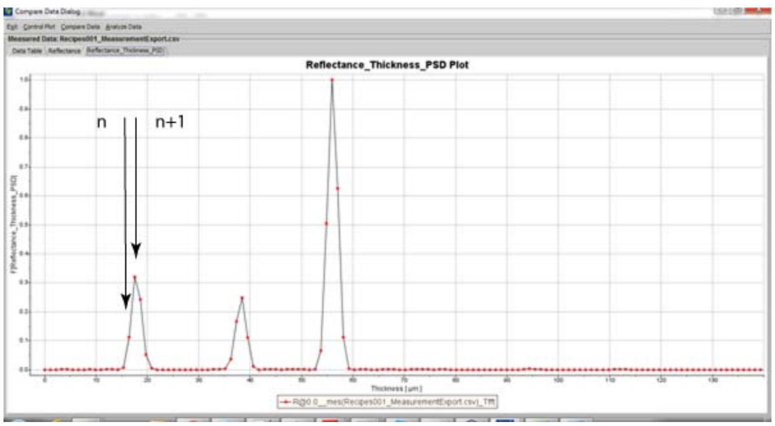

Fig. 1. FFT points resolution. Distance between adjacent FFT points (bins) determines maximum error.

To improve accuracy one can:
1. Increase the number of points
2. Interpolate between the points
3. Fit a Gaussian to a peak and determine position from the fitted function.
4. Apodization (filter the data). It does not, in most cases, improve accuracy directly but helps avoid aliases and additional peaks, especially in noisy signals.

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All these options are now available in the software and are reviewed here using an example of a coating on polymer film.

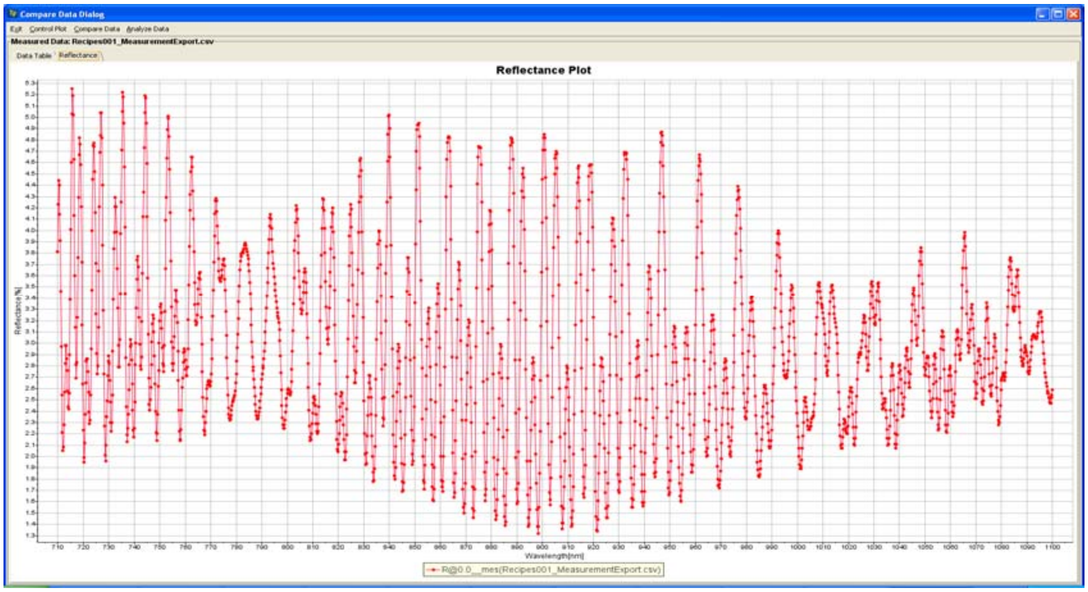

Fig. 2 Measured reflectance spectrum of coating (~ 18 µm) on 38 µm PET

I. Increasing the number of points

FFT points are spread in the maximum measurable thickness range. Frequently, only part of the thickness range is of interest. In our example, the maximum measurable thickness is 280 µm but the thicknesses of the sample are 18 µm and 38 µm.
We can increase the number of points using a method that is sometimes called "oversampling".

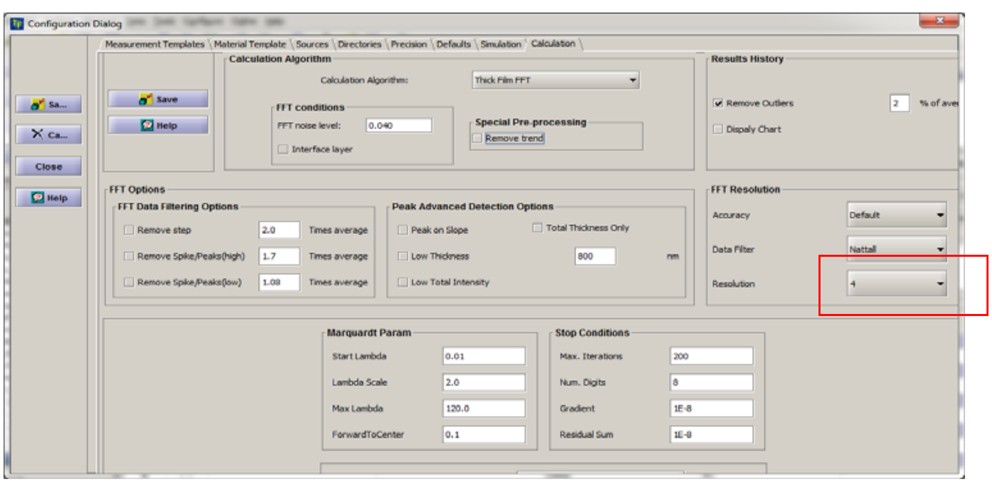

Fig. 3. Resolution improvement by using increased number of FFT points. 1 is default resolution, 4 – maximum resolution

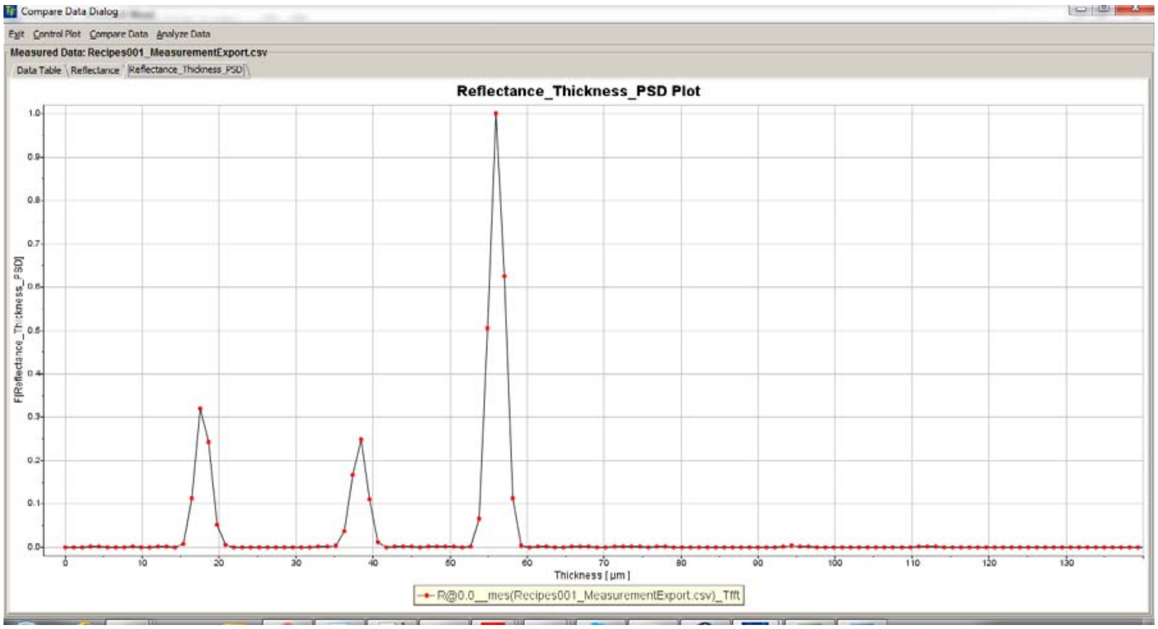

Fig. 4 Peaks using default resolution (1)

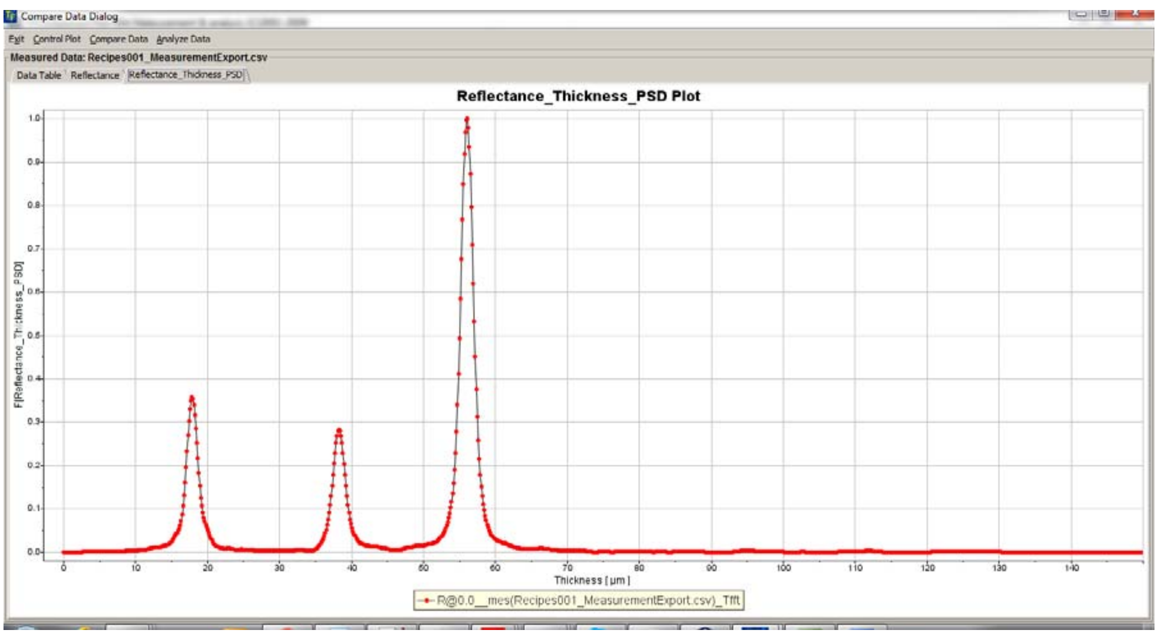

Fig. 5 Peaks using high resolution (4)

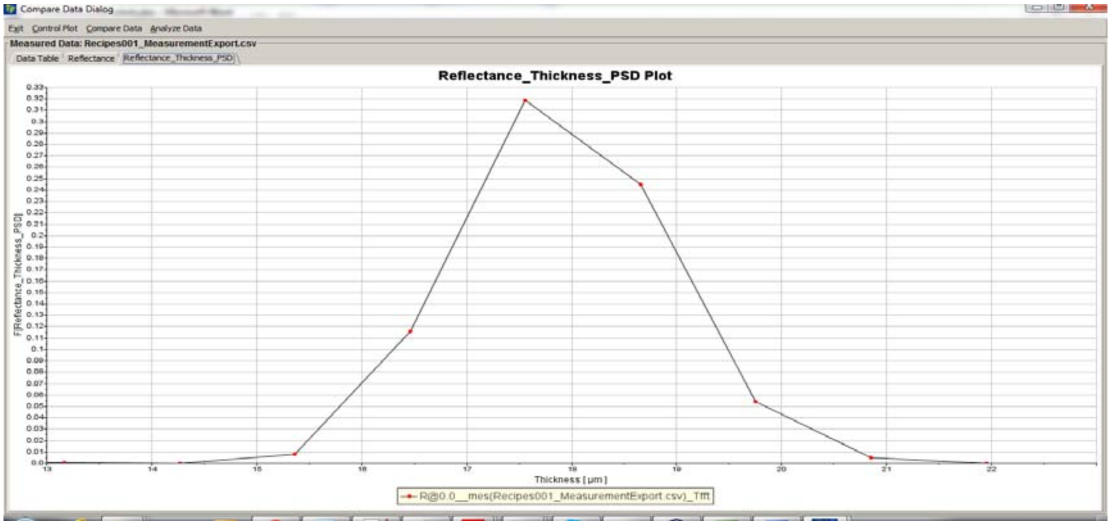

Fig. 6 Peak detail from fig. 4 (default resolution - 1)

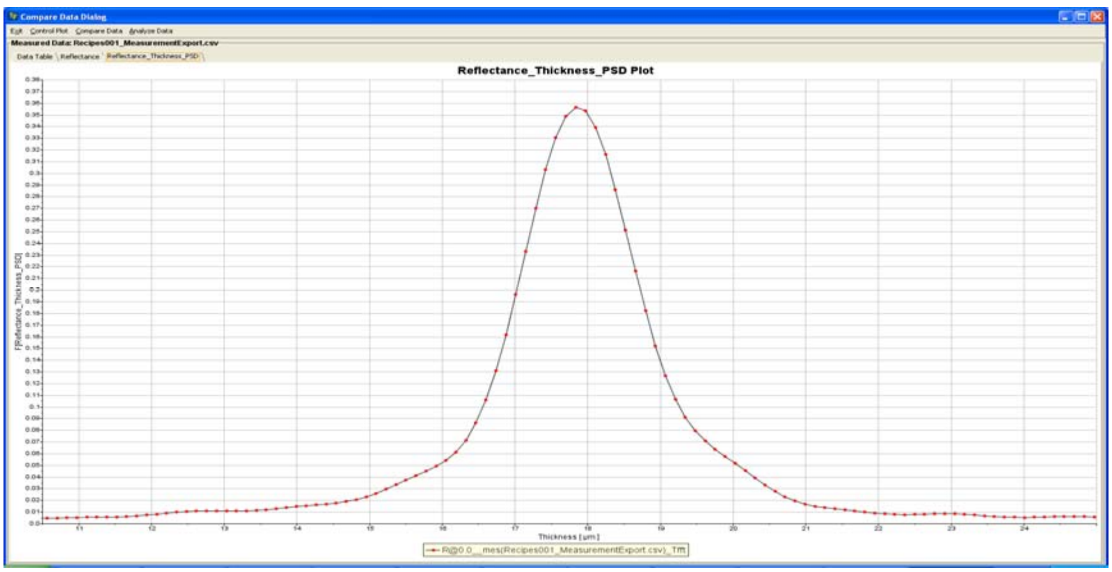

Fig.7 Peak detail from Fig. 5 (high resolution -4)

Resolution	**1**	**2**	**3**	**4**
Maximum possible error (µm)	0.548	0.274	0.137	0.068

Table. 1 Maximum possible measurement error depending on the resolution

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II. Interpolation between the points or curve fit.

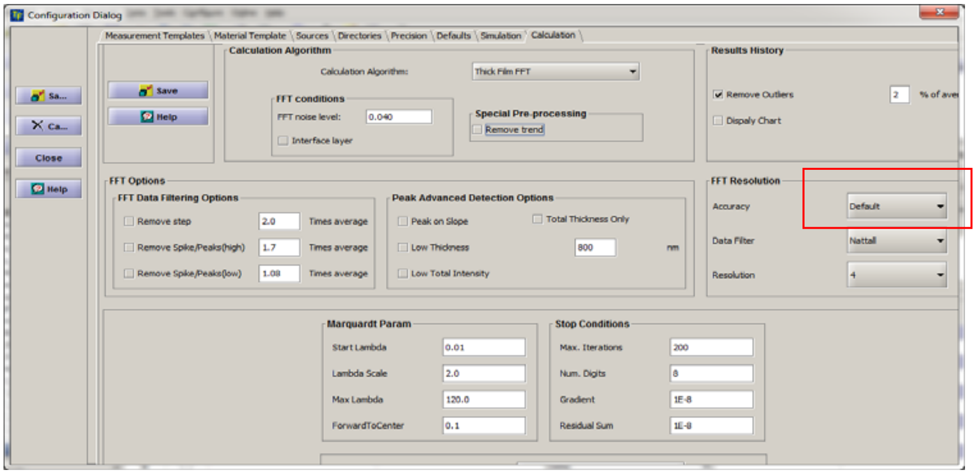

Fig. 8. Selecting accuracy level.

Three levels of accuracy are available:
a). Default – no interpolation or fit
b). High accuracy. Gaussian interpolation between the points
c). Maximum accuracy. Gaussian curve fit to the peak.

Resolution/Accuracy	1	2	3	4
Default	-0.3547	0.2166	-0.0691	-0.0691
High	-0.0402	-0.0475	-0.0563	-0.0625
Maximum	-0.0136	0.0005	0.0068	0

Table 2. Actual measurement error (in µm) depending on the Accuracy/ resolution setting. 1
8.6381 µm determined at the maximum accuracy/resolution setting is used as a reference ("true" thickness value).

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III. Apodization – data filtering

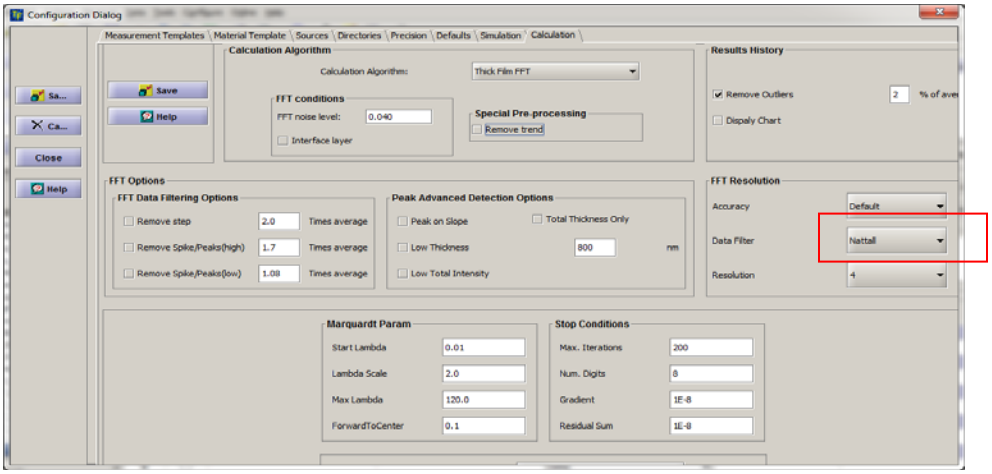

Fig. 9 Selecting apodization filter

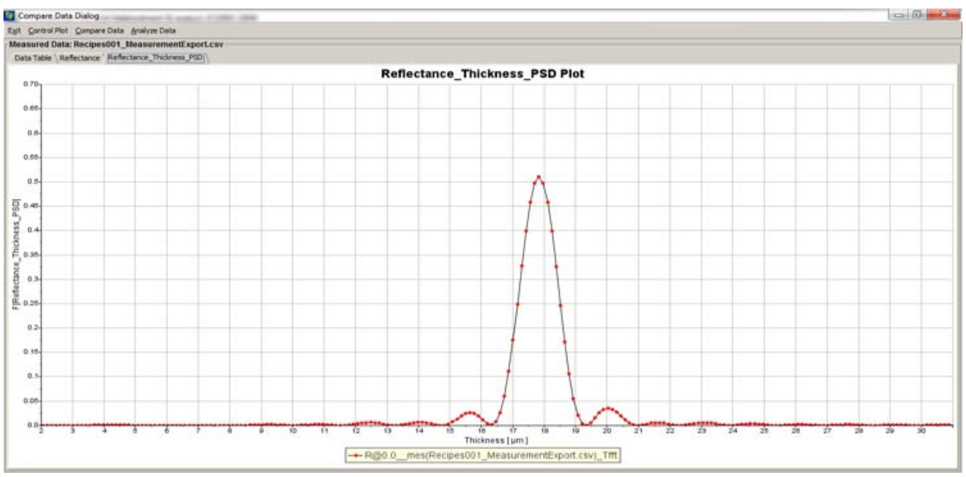

Fig. 10. Peak without data apodization.

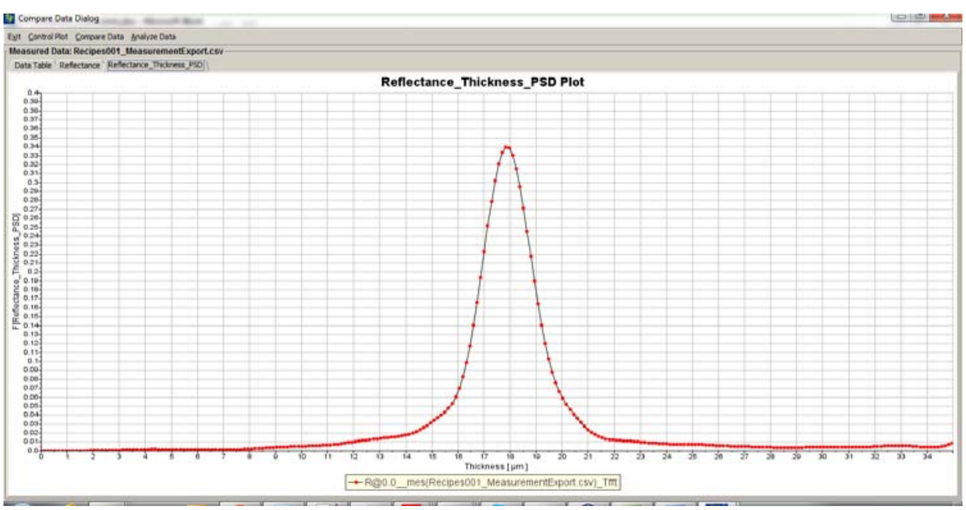

Fig. 11. Peak with data apodization (peak is the same as on Fig. 10)

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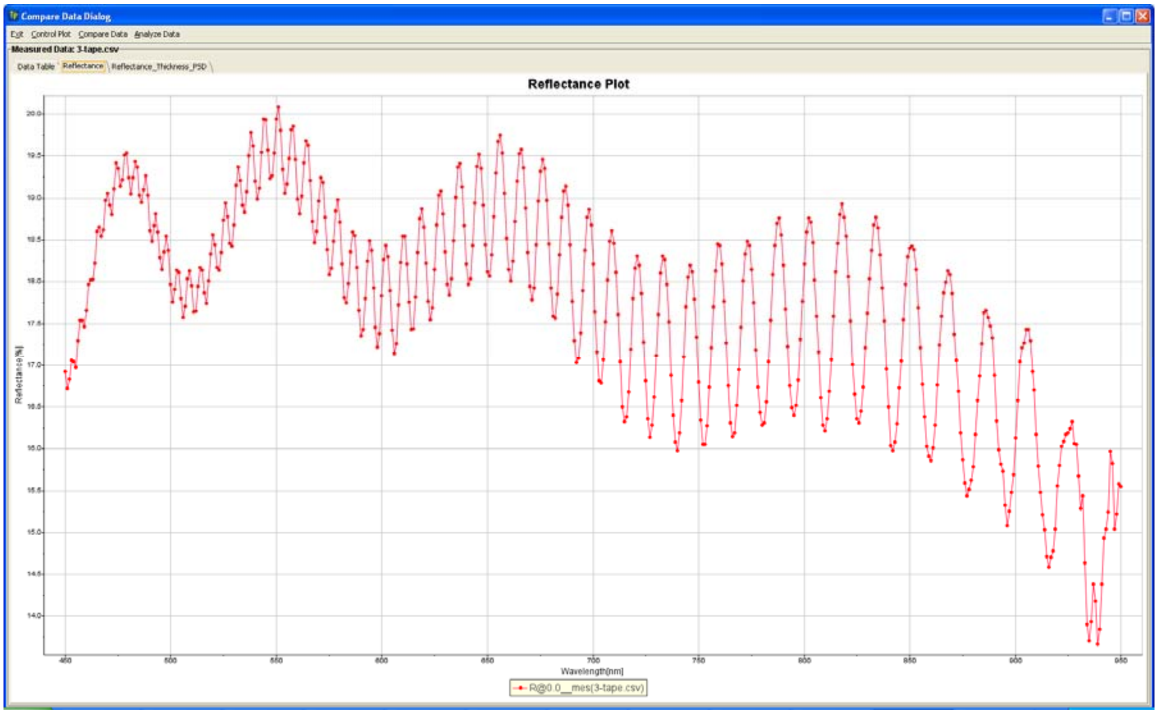

Fig. 12. Reflectance spectrum of GaN on sapphire

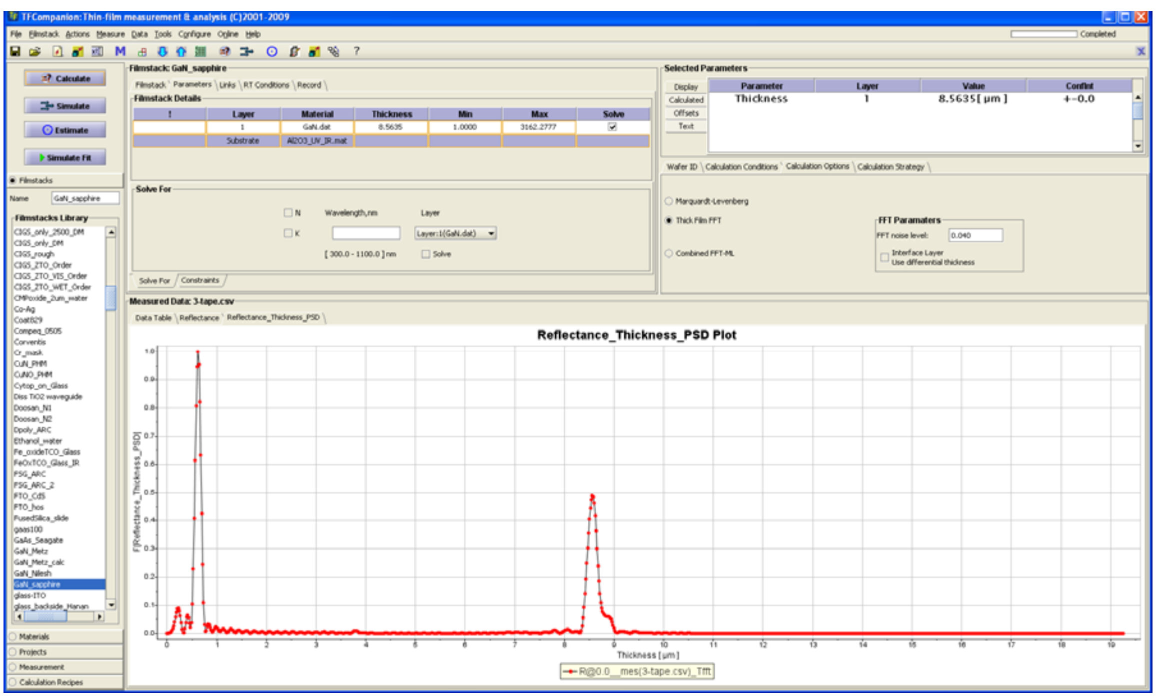

Fig. 13 Measurement of GaN (fig. 12) without data apodization

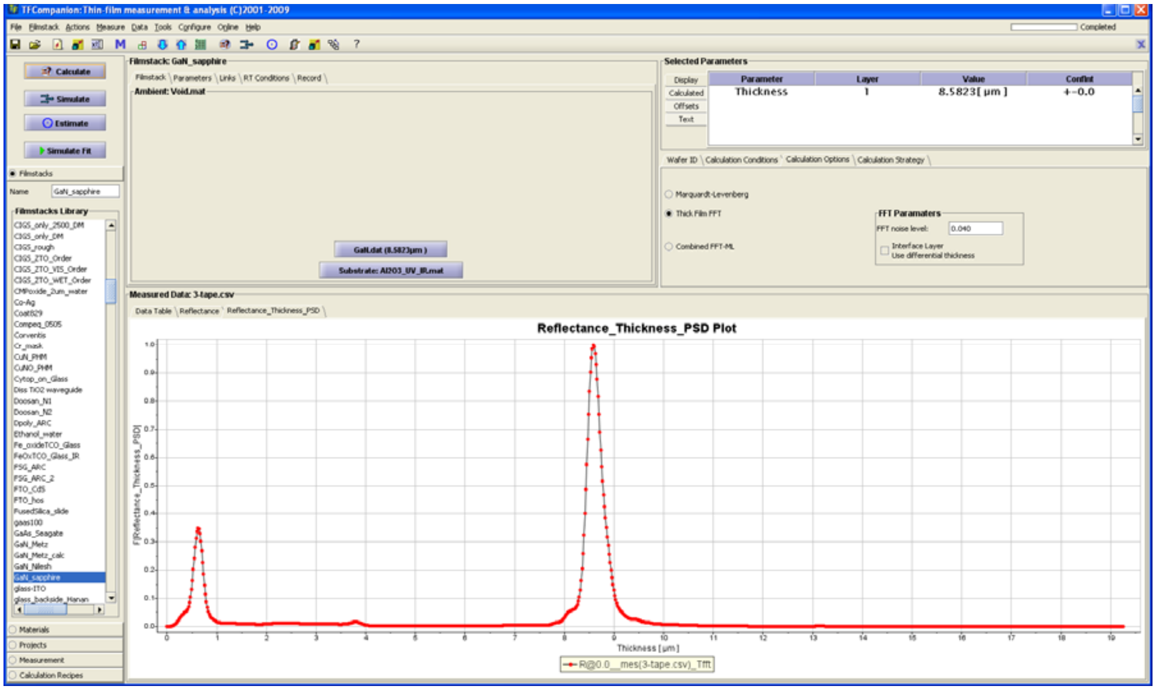

Fig. 14 Measurement of GaN (Fig. 12) with data apodization

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