Signal Windowing in Terahertz Time-Domain Spectroscopy

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1. Introduction

Signal truncation in terahertz (THz) time-domain spectroscopy (TDS) introduces artifacts in the frequency domain due to the abrupt change of the signal value at the boundaries. Because of this, commonly used window functions have been investigated for using in THz-TDS by windowing both the signals at once [1]. In this study, the pulses are centered by truncating from the one side and zero-padding from the other, and then the windowing performance is compared when using one common windowing and separate windowing for the pulses.

2. Processing of the measured THz data

Measurement

A 5 mm thick sample of sunflower oil has been inserted into a transmission mode THz-TDS system. The unwindowed and windowed measured pulses are shown in Fig. 1. The pulses are commonly windowed by centering them together to the middle of the windowing function. For the separate windowing, the pulses are centered separately.

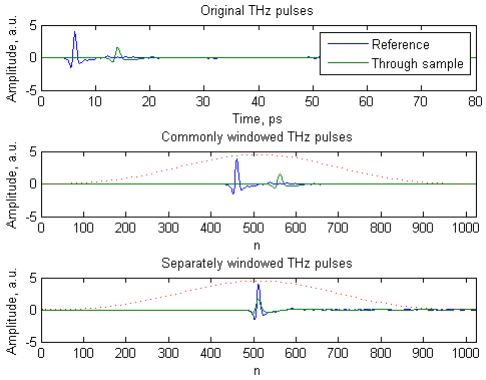

Figure 1. The measured reference (blue) and sunflower oil sample (green) THz pulses in their original form (top), commonly windowed (middle) and separately windowed (bottom) along with a scaled Blackman windowing function (red dotted).

Processed data

Fig. 2 shows the obtained refractive index for the sunflower oil sample. It is seen that the separate windowing provides the most accurate result with respect to reported spectral data for oils [2]. A similar result is obtained for the absorption coefficient shown in Fig. 3.

3. Conclusions

The separate windowing of the pulses provides superior performance in THz-TDS. Advanced windowing based on novel methodologies for finite impulse response filter design [3] can be further investigated for obtaining more accurate results in THz-TDS.

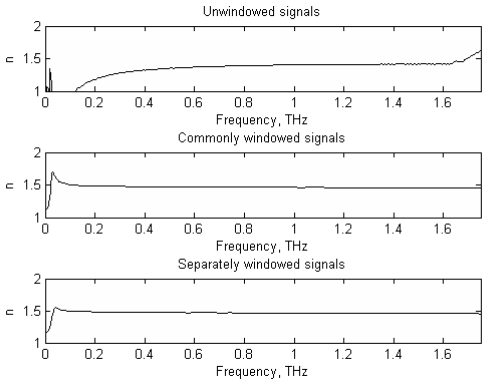

Figure 2. The obtained refractive index of the sunflower oil sample with unwindowed signals (top), commonly windowed signals (middle) and separately windowed signals (bottom).

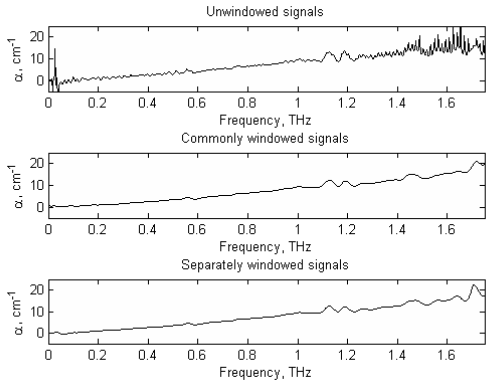

Figure 3. The obtained absorption coefficient of the sunflower oil sample with unwindowed signals (top), commonly windowed signals (middle) and separately windowed signals (bottom).

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References

[1] W. Lai, H. Zhang, Y. Zhu, Q. Wen and Y. Ma, Spectroscopy Lett. **47** (2014) 590–596.
[2] H. Yang, J. Irudayaj, M. M. Paradkar, Food Chem.93 (2005) 25–32
[3] P. Apostolov, Elsevier Sig. Proc. **91** (2011) 2589–2596