Characterisation of amorphous and crystalline domains using terahertz spectroscopy

M.E. Marlow[2], H. Seker [2] and G. Smith[1]
[1]School of Pharmacy and [2]Centre for Computational Intelligence, De Montfort University, Leicester, LE1 9BH, UK,
[3] School of Pharmacy, University of Nottingham, Nottingham, NG7 2RD, UK.

INTRODUCTION

The centre portion of the terahertz region has a unique combination of properties in that: many amorphous excipients are transparent or semi-transparent to terahertz radiation whilst many crystalline materials have characteristic spectral features.

The research presented here is focused on developing methods for characterising crystalline and amorphous domains in drug products. A model system of tablets comprised of either Avicel® PH-101 or polyethylene (PE) (both transparent to terahertz) with lactose monohydrate have been used to evaluate terahertz spectroscopy methods in the transmission and reflection modes.

MATERIALS AND METHODS

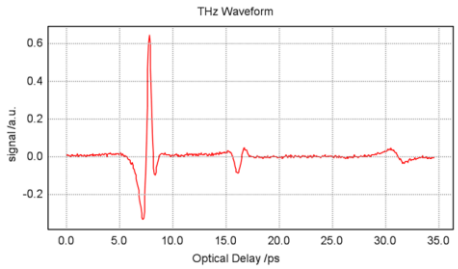
For the transmission measurements two layered tablets with one polyethylene(PE) layer and a lactose and PE layer were manufactured by lightly compressing the first PE layer then adding a PE/lactose layer. For the reflection measurements two thin tablets of either Avicel alone or Avicel and lactose monohydrate were manufactured to create distinct domains with and without crystallinity. For both transmission and reflection measurements the time domain signal was recorded using the Teraview TPI 3000 (Teraview, Cambridge, UK). Terahertz images were obtained by raster scanning the terahertz beam across the sample. Analysis of the reflected time domain signal was carried out using Wavelet Transform with Daubechies db1[1] and secondly using Discrete Fourier Analysis.

RESULTS AND DISCUSSION

For equivalent amounts of lactose either totally mixed in PE or in a PE/lactose layer with similar thicknesses the time domain signal was similar in transmission mode (data not shown).

Using time domain signals acquired in the reflection mode, Figure 1 shows (a) terahertz image showing the discrete layers of two Avicel tablets 100mg and 200mg and (b) an example of terahertz time domain signal from the surface. Both signal processing methods were able to show differences in response between crystalline and amorphous tablets.

(a)



(b)

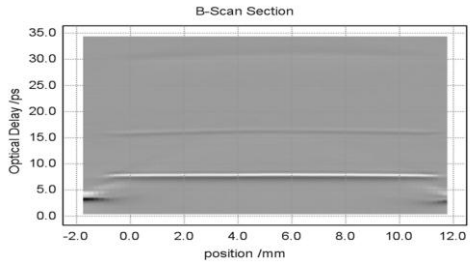


Fig. 1. (a) an example of reflected terahertz time domain signal and (b) terahertz image showing the discrete layers of two Avicel tablets 100mg and Avicel 200mg with 20% lactose

CONCLUSIONS

In summary, the transmission mode is not able to distinguish between crystalline layers or domains in tablets. However, the terahertz reflected time domain signal has the potential to discriminate between crystalline and amorphous layers in tablets.

ACKNOWLEDGMENTS Dr Marlow was a Gunn and Carter fellow when undertaking this research, which was funded by the alumni of De Montfort University.

REFERENCES

[1] Daubechies, I. (1992), *Ten lectures on wavelets*, CBMS-NSF conference series in applied mathematics. SIAM Ed.