

1. Introduction

- Pharmaceutical tablets are commonly spray-coated with film layers for cosmetic or functional purposes.
- The inter- and intra-tablet coating thickness variabilities are crucial parameters in determining the quality of the coating process and the final tablet products.
- In this study, the spray coating process of pharmaceutical tablets and its in-line measurement were modelled and analysed using discrete element method (DEM) simulations combined with image analysis and ray-tracing methods.

3. DEM Modelling of Spray Coating

- The spray coating process of various tablets was modelled using DEM [1] and image analysis method [2], and a ray-tracing method [3] was used to model the coating process and sample the location of coating deposition.

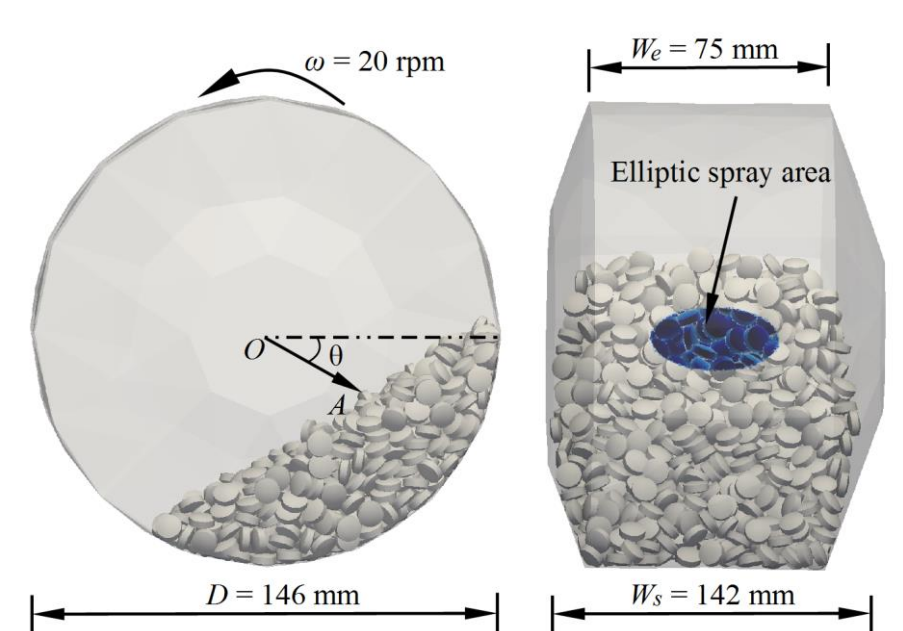


Figure 1: DEM model of spray coating

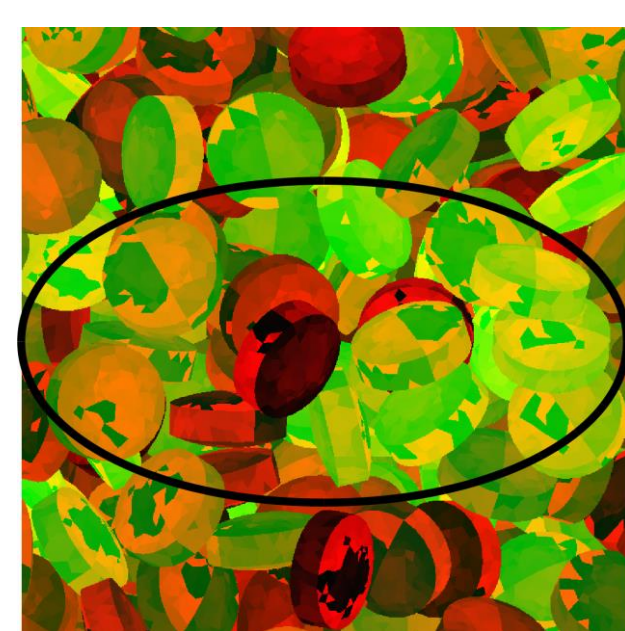


Figure 2: Image analysis of spray zone (black ellipse)

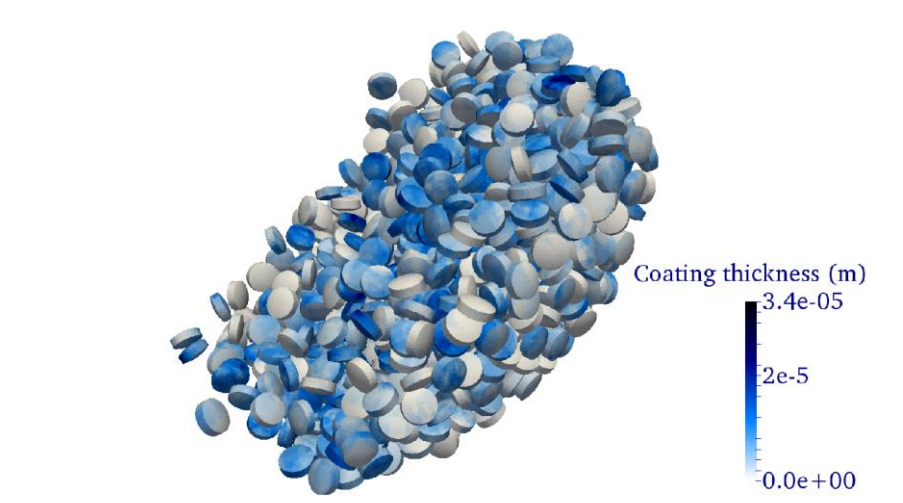


Figure 3: Coated tablets during spray coating

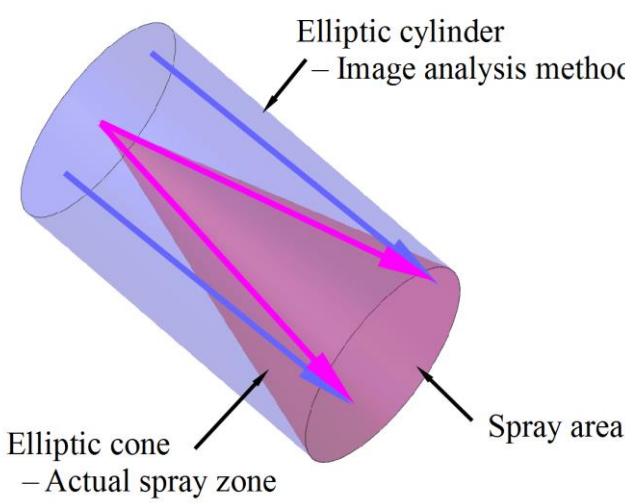


Figure 4: Ray-tracing following spray direction

- The cap-to-band coating thickness ratio should be equal to the cap-to-band projected area ratio normalised by the cap-to-band surface area ratio. If not, there will be a non-zero asymptotic value of intra-tablet variability.

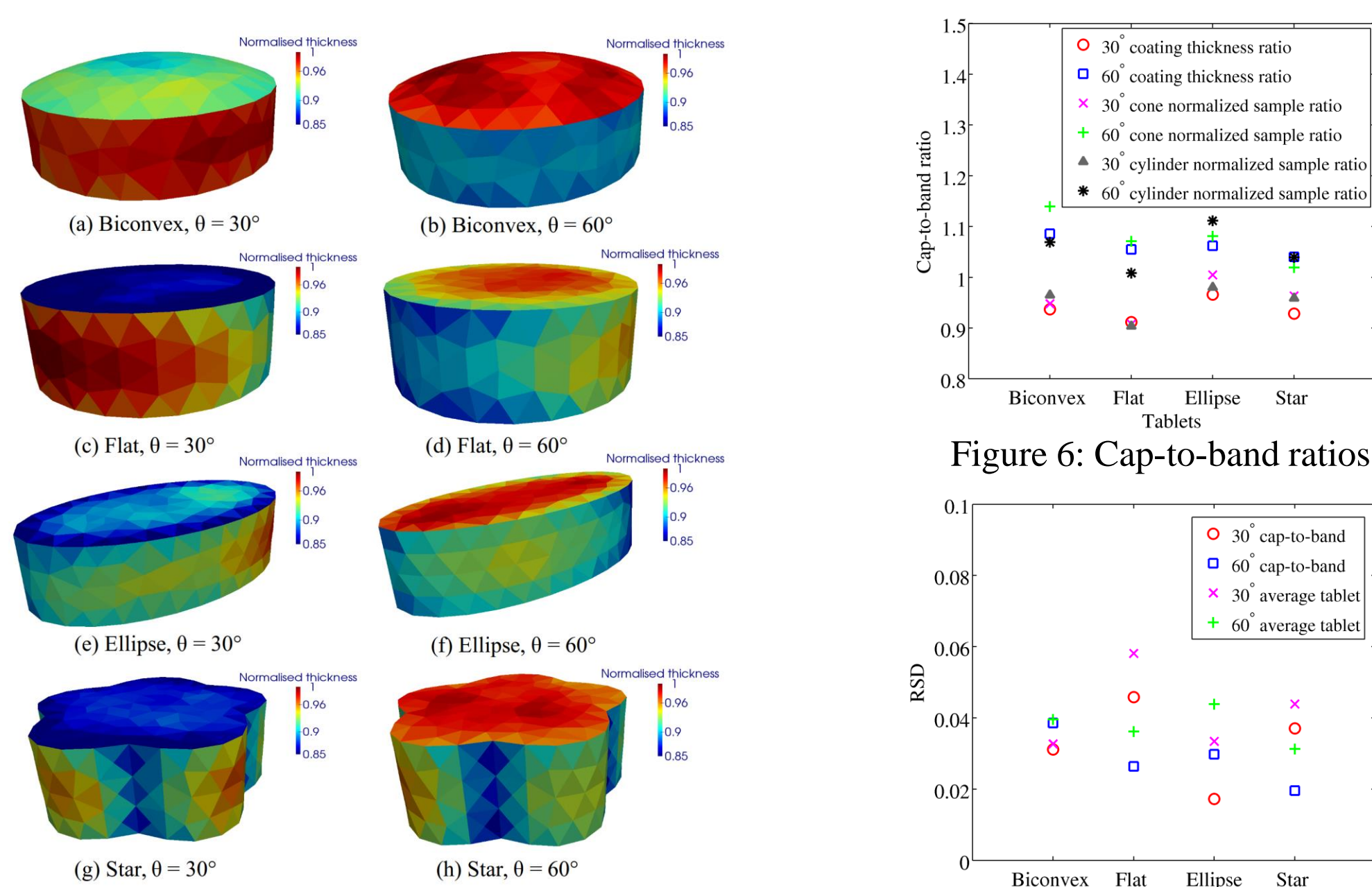


Figure 5: Coating thickness of various tablets

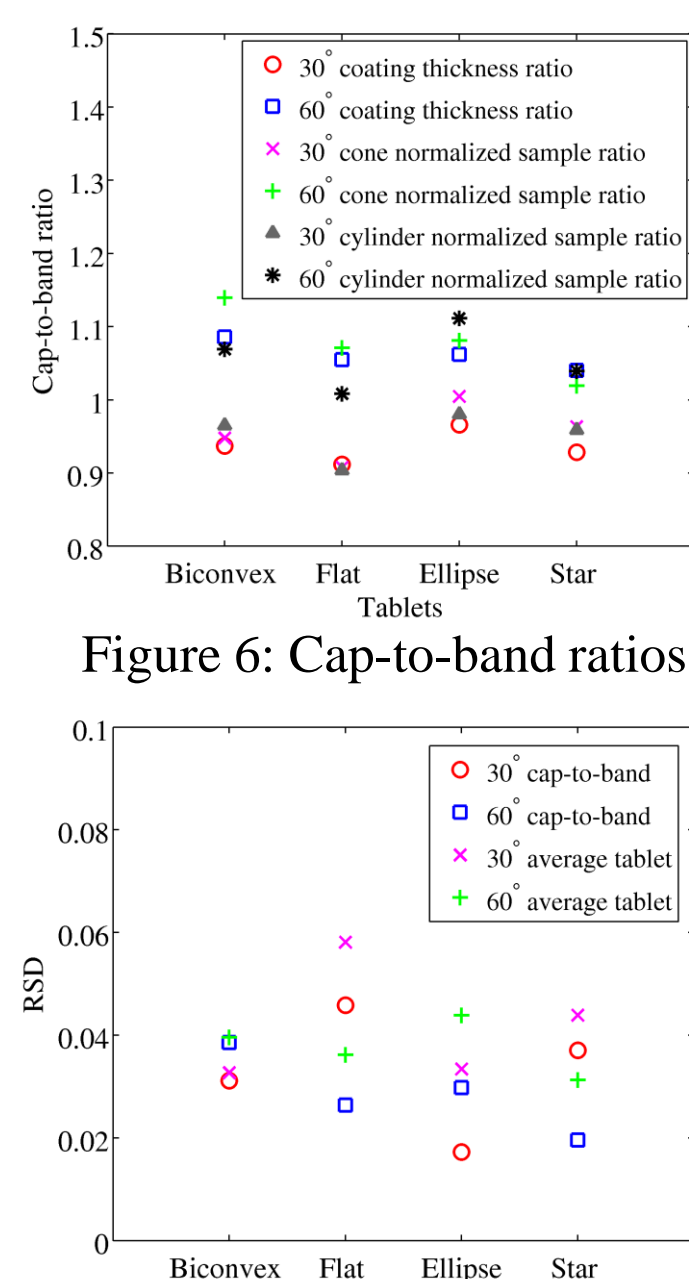
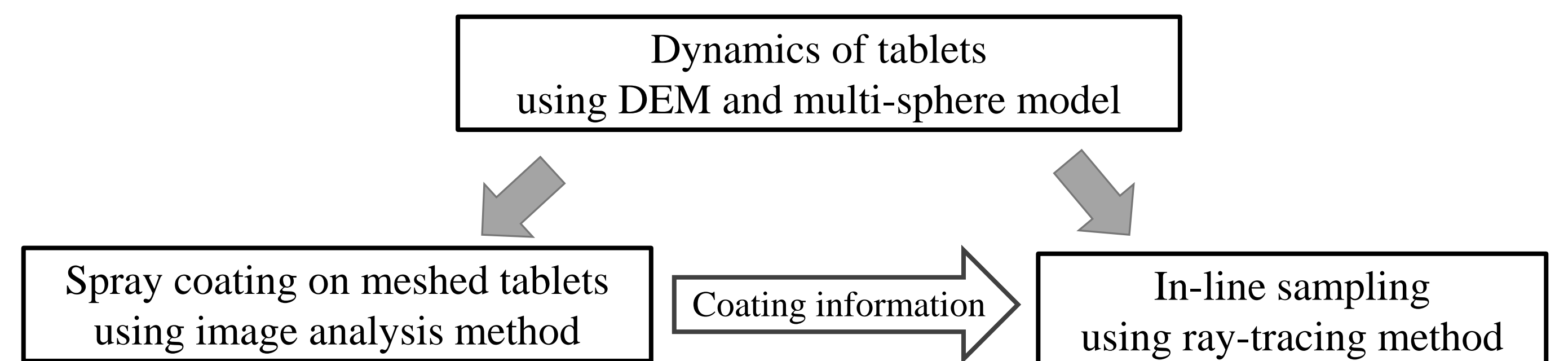


Figure 6: Asymptotic values due to cap-to-band ratio

5. Future Scope

- The influence of process conditions on the spray coating process.
- The modelling of in-line sampling of coating thickness during spray coating of tablets.
- Modelling of optical coherence tomography (OCT) to study thinner coating thicknesses (< 40 μm).
- Big data analysis based on numerical and experimental data.

2. Modelling Scheme



4. Ray-Tracing of Coating Thickness during Mixing

- The terahertz in-line sampling method in experiments is modelled using a ray-tracing method to sample the coating thickness of pre-coated tablets during mixing.

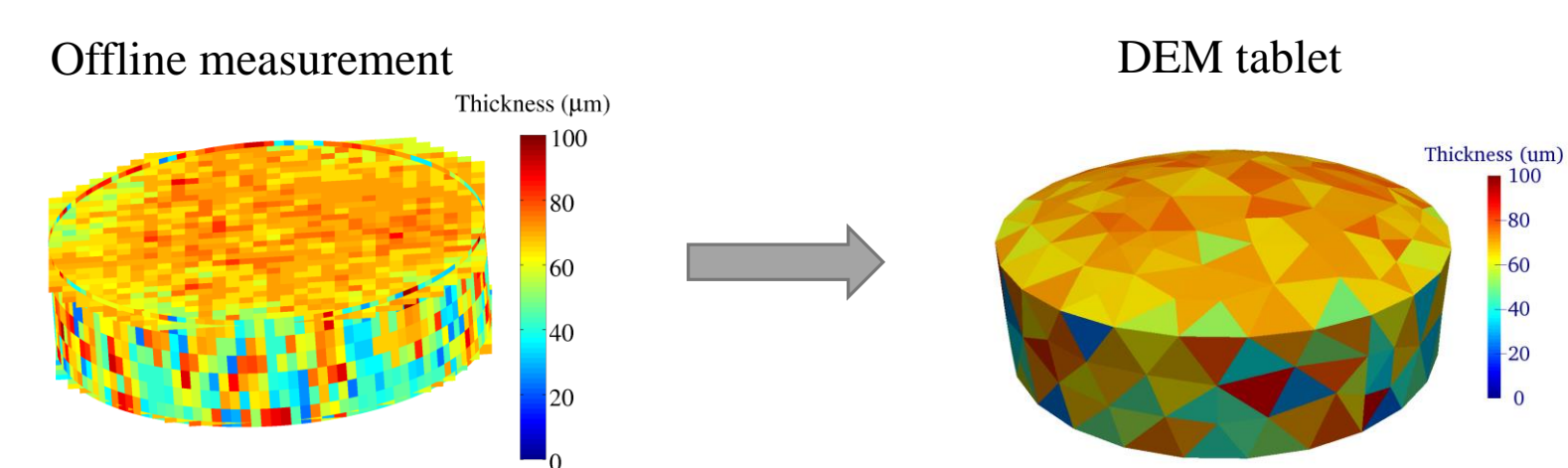


Figure 8: The coating thickness of DEM tablets mapped from offline measurement

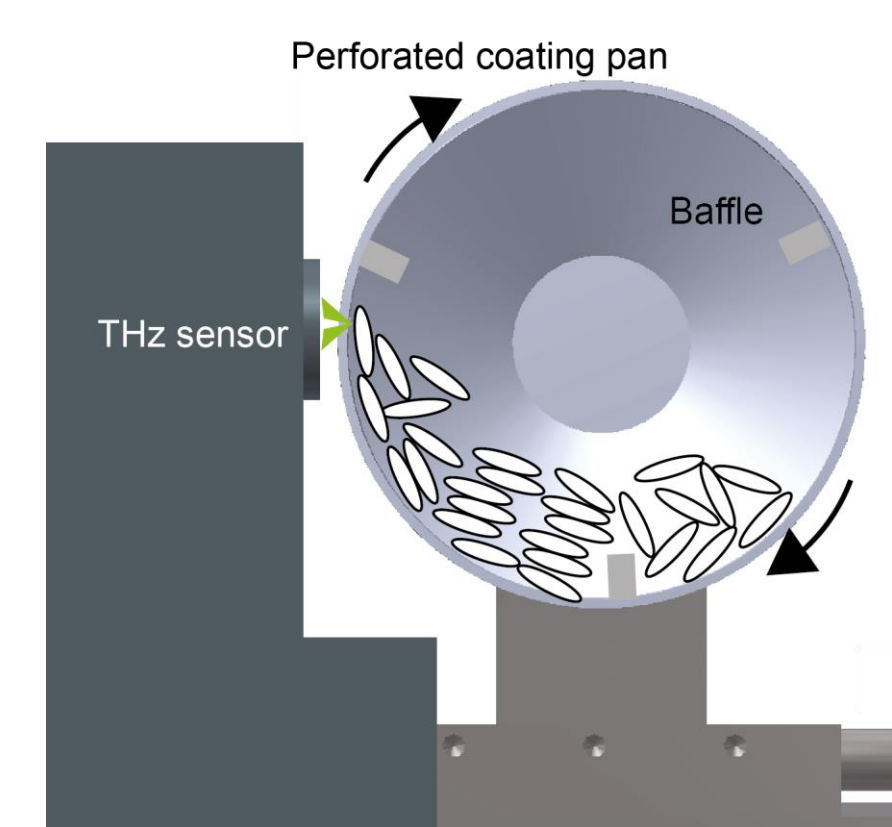


Figure 9: Experimental setup [4]

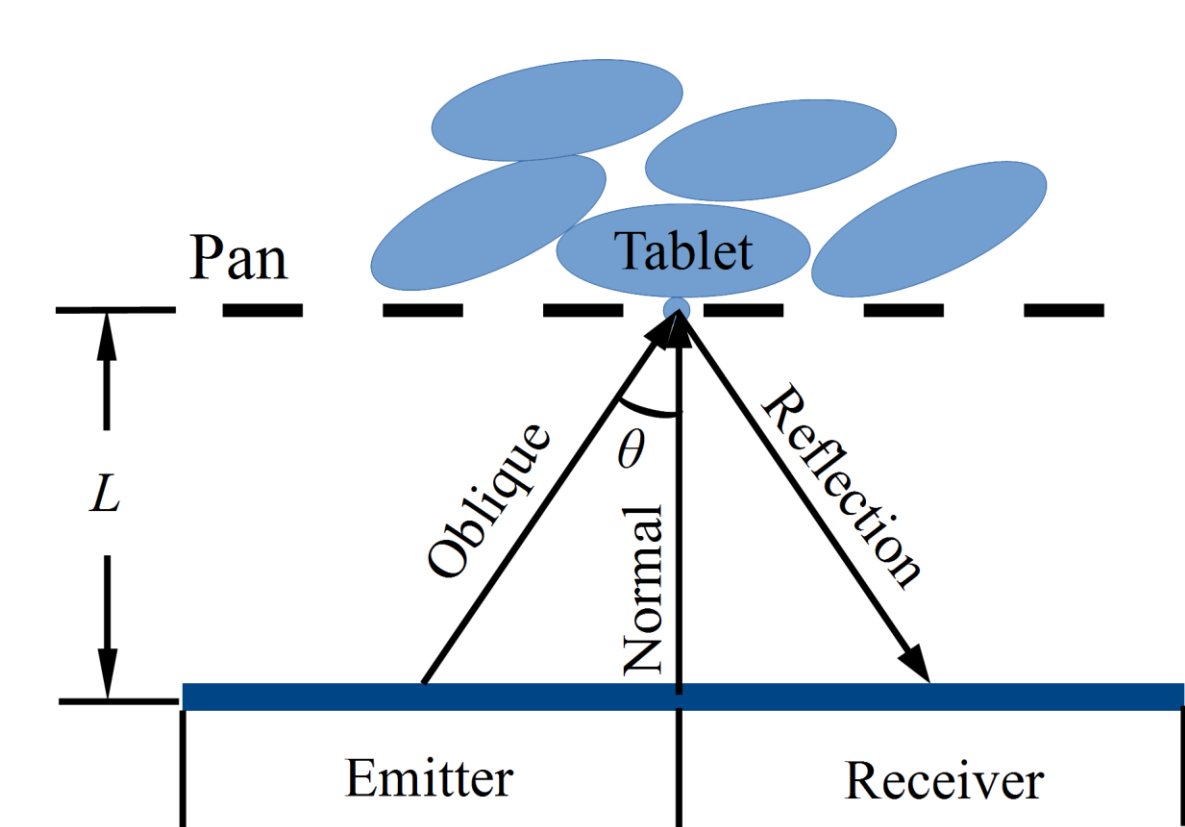


Figure 10: Ray-tracing modes

- The hit rate in the reflection mode matches the experimental data, while the direct modes (normal and oblique) gives a significantly larger hit ratio.

- The ray-traced coating thickness distribution agrees well with the inline measurements using terahertz from experiments.

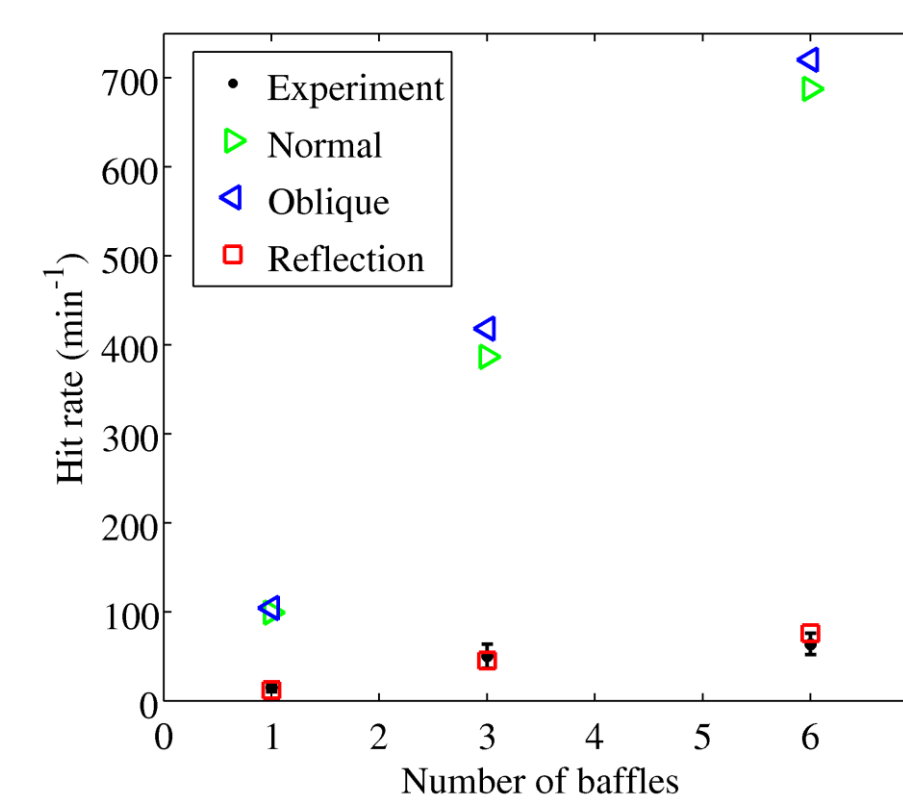


Figure 11: Hit rates of various ray-tracing modes

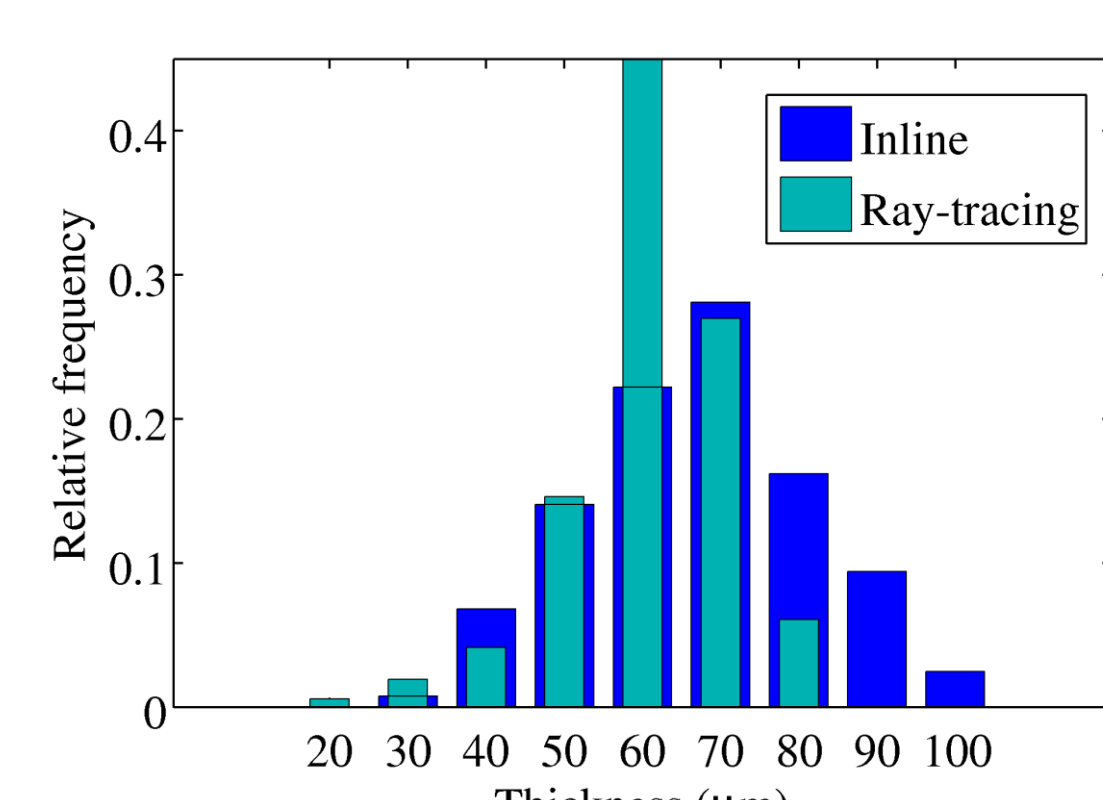


Figure 12: Coating thickness distribution from modelling and experiments

Collaborations

- Tablet shape can be obtained from WP 4.9.
- Numerical and experimental data can be used for big data in WP 3.

References

- [1] Kloss, C. et al., Prog. Comput. Fluid Dy., An Int. J., 2012(12): 140–152
- [2] Freireich, B et al, Chem. Eng. Sci. 2015(131): 197–212
- [3] Toschkoff, G, et al., J. Pharm. Sci. 2015(104): 4082–4092
- [4] Courtesy of Drs J. Axel Zeitler and Hungyen Lin from University of Cambridge