

Influence of physicochemical, rheological and process parameters on the ultrasonic spray coating of polymer films

Sander Provo

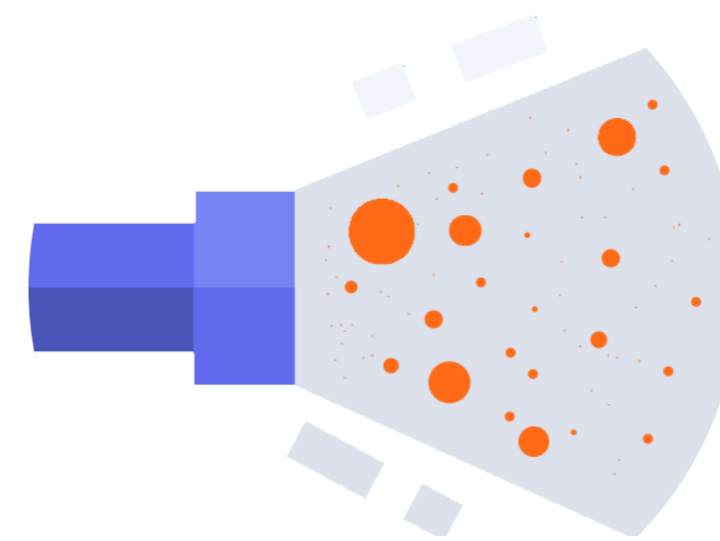
Master of Chemical Engineering Technology

Polymer films can be applied as functional coatings on top of substrates to enhance surface properties and morphology



Which coating formulation is studied?

- Polyvinylidene fluoride (PVDF)
- Acetone solvent
- SiO₂-nanoparticles



How is the coating applied?

- Sono-Tek
- Exactacoat Ultrasonic Coating System
- Impact nozzle
- **Ultrasonic atomisation**

Research objectives

Acquiring insight in the effect of physicochemical and rheological properties on **dispensing** of the coating formulation

Studying the influence of material-properties and process parameters on **atomisation** and subsequent **droplet formation**

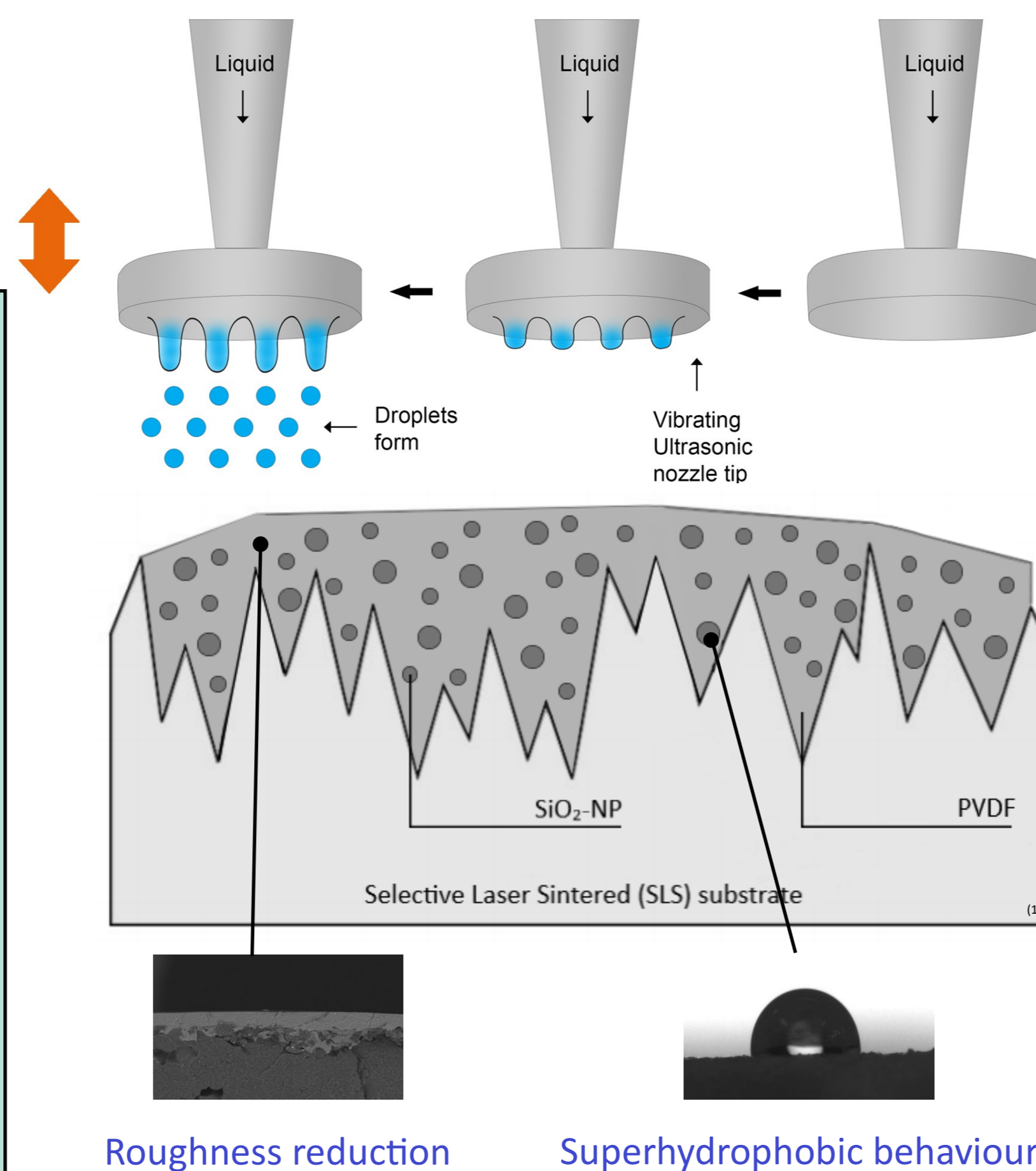
Investigating which parameters regulate the **deposition of the polymer layer** onto the substrate surface

Methodology

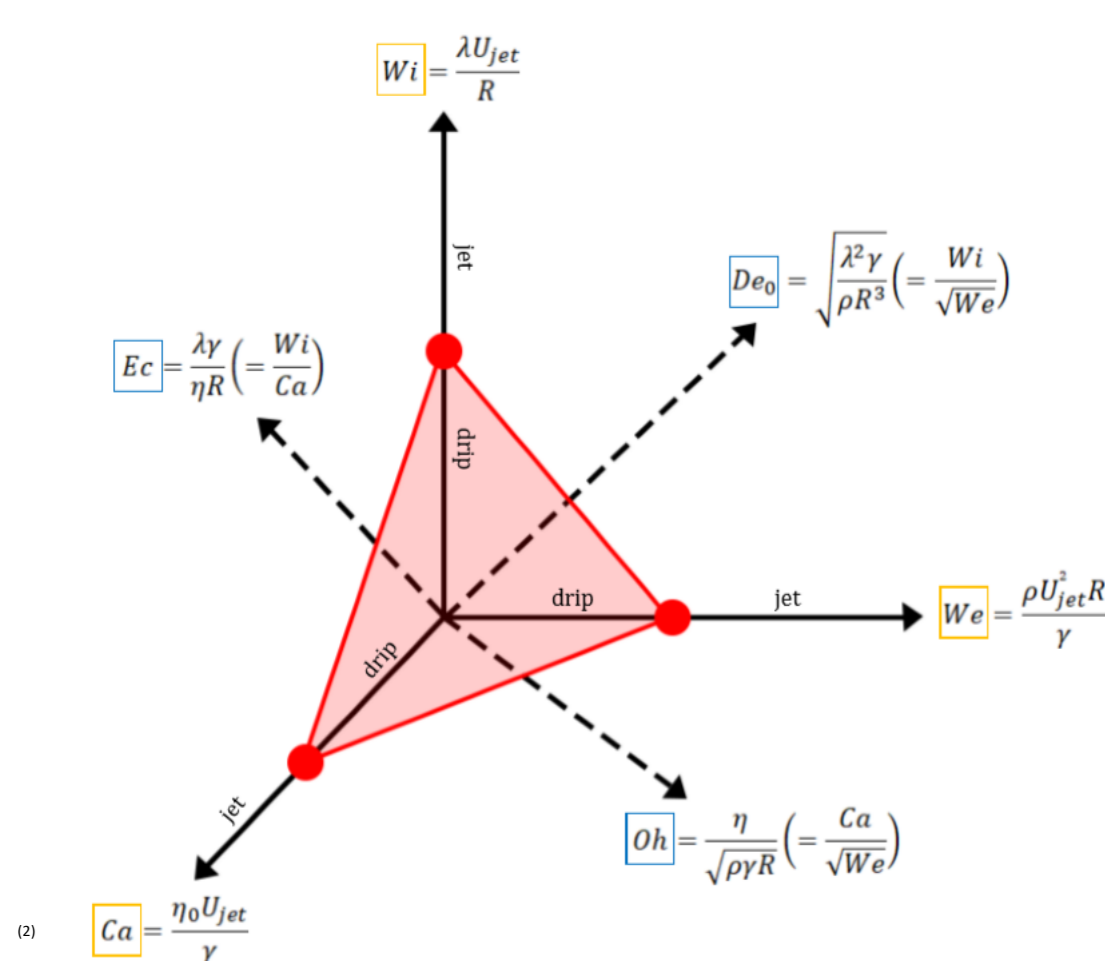
Analysing material-property-based nondimensional numbers based on previously performed experimental studies to obtain a **dimensionless operating space** for ultrasonic spray coating

Atomisation and subsequent formation of droplets is predicted using **theoretical models** that govern rheological, physicochemical and process parameters and then compared to measured values

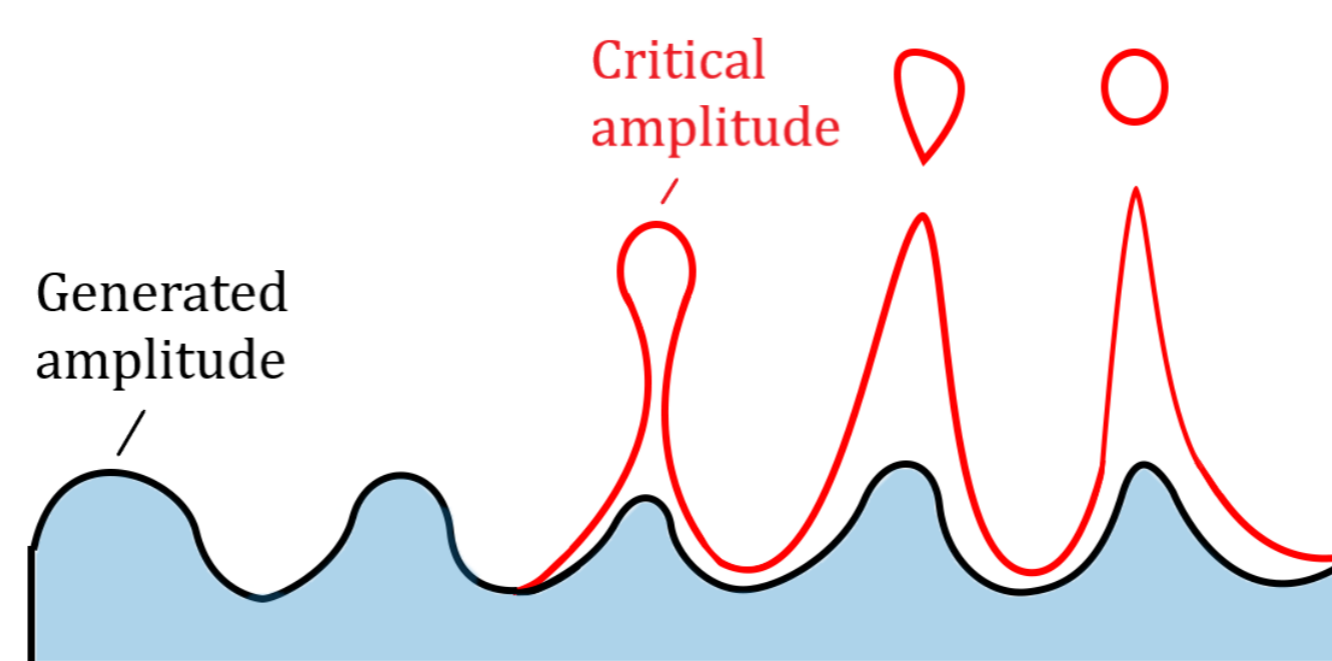
Parameters affecting the deposition of polymer films on substrates will be investigated and the **evaporation** of a sprayed droplet is studied



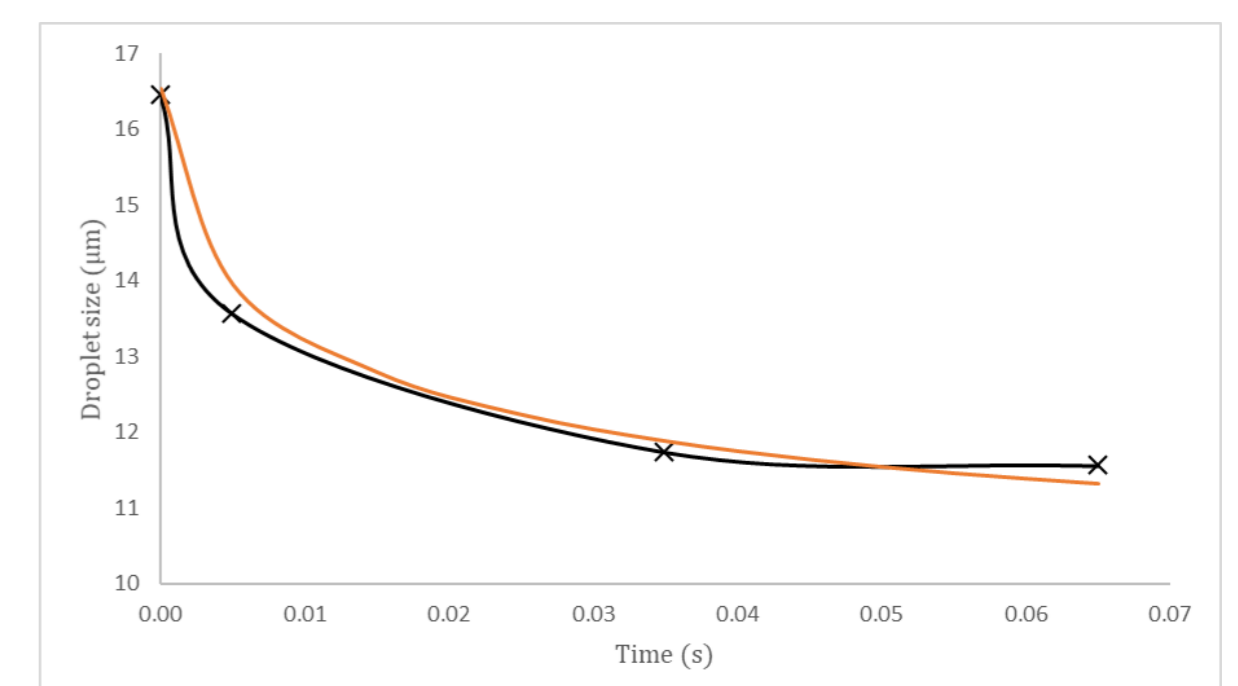
Conclusions



A detailed study on the material-property-based dimensionless numbers indicates that the filament thinning for a coating formulation of 5 wt% PVDF in acetone is dominated by **elastic effects**



Theoretical models were fitted and compared to measured values. Atomisation (i.e. amplitude generation and formation of small droplets) was found to **occur more easily** than theoretically predicted



The **evaporation rate** (which is proportional to the **nozzle height**) of the acetone solvent was studied and was found to scale according to **exp(-κ√t)**

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(1) S. Slegers, M. Linzas, J. Drijkoningen, J. D'Haen, N. Reddy, and W. Deferme, "Surface Roughness Reduction of Additive Manufactured Products by Applying a Functional Coating Using Ultrasonic Spray Coating," *Coatings*, 2017, doi: 10.3390/coatings7120208.
(2) C. Clasen, P. M. Phillips, L. Palangtich, and J. Vermant, "Dispensing of rheologically complex fluids: The map of misery," *AIChE J.*, 2012, doi: 10.1002/aic.13704.