

A Waveform Design Practice Guided by Rheology for Achieving Satellite-Free Droplet Formation in 3D Inkjet Printing

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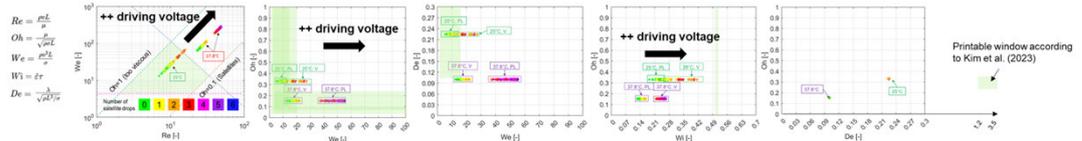
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Motivation and Aim

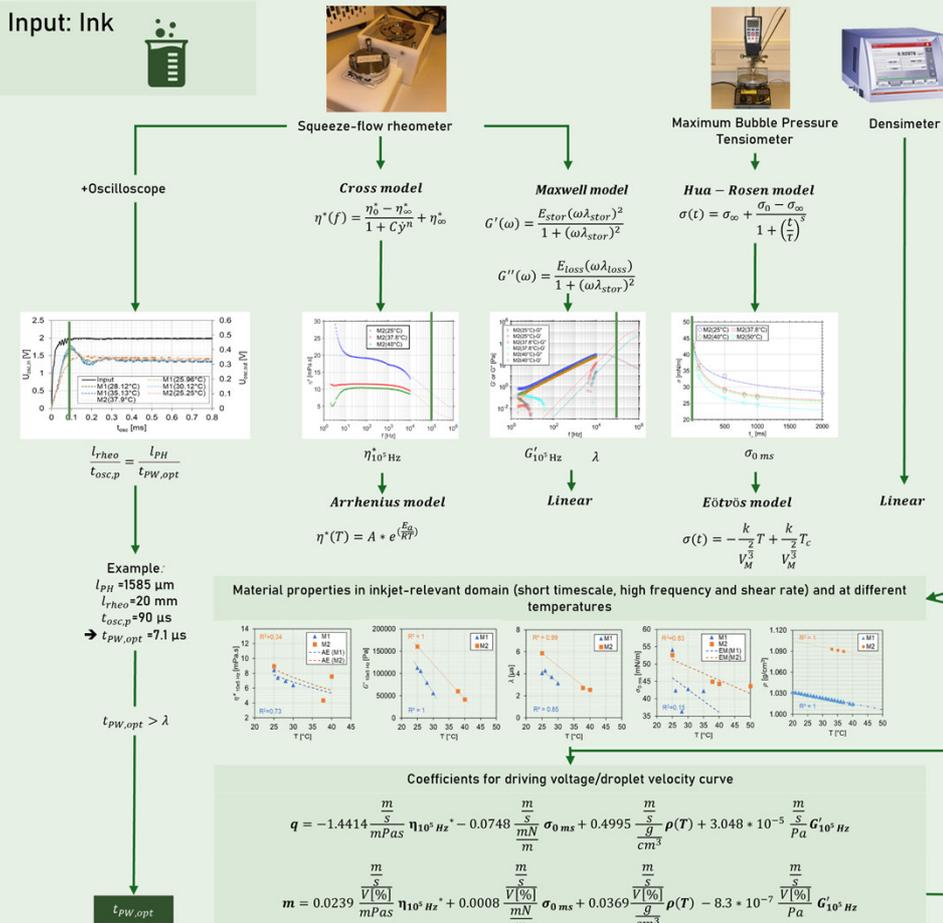
- Printability windows based on dimensionless numbers
- Derby et al. (2010): $We < 4, 0.1 > Oh > 1$
 - Jang et al. (2009): $We \geq 3, 0.07 \leq Oh \leq 0.25$
 - Du et al. (2018): $We \geq 3, 0.02 \leq Oh \leq 0.1, Wi = 0.5$
 - Liu et al. (2019): $1 < We < 20, 0.025 < Oh < 1$
 - Kim et al. (2023): $1.2 < De < 3.5, 0.25 < Oh < 0.38$
 - Richardot et al. (2025): $2 < We \leq 15, 0.1 < De < 1$



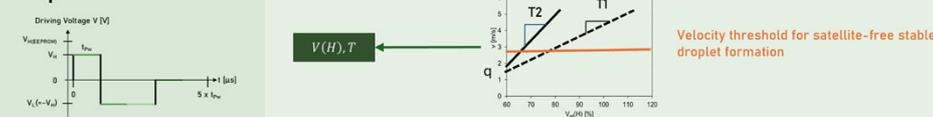
Conventional approaches to assessing ink printability and avoidance of satellite droplets are often inaccurate, overlooking the non-Newtonian behaviour of polymer-based inkjet materials. This study presents a systematic approach to identify stable single-droplet waveforms based on rheological properties, accounting for the non-Newtonian behaviour of polymer-based inkjet inks and dynamic conditions.

Rheology-based Waveform Design Approach

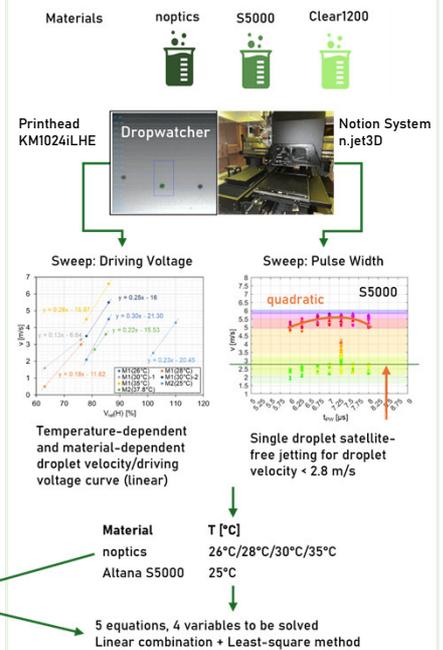
Input: Ink



Output: Waveform



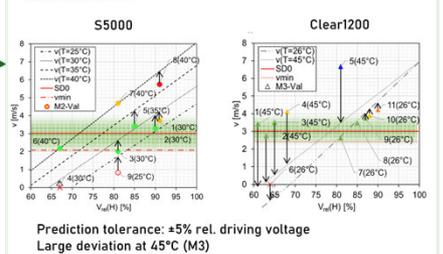
Initial Investigation



Full paper: K. J. Chen, V. Hagenmeyer, and A. Elkaseer, "Satellite-free droplet formation in material jetting via rheology-driven waveform modelling approach," *Materials & Design*, vol. 260, 2025, doi: 10.1016/j.matdes.2025.115252.



Validation



Conclusion

Satellite droplets are absent below a droplet velocity of 3 m/s. A linear correlation between driving voltage and droplet velocity was observed. A rheology-informed predictive model relating driving voltage and droplet velocity enables efficient identification and optimization of stable single-droplet waveform, with limitation at higher temperatures.