Mixing within Coalescing Droplets of Different Fluids

UK Fluids Network Short Research Visit Report

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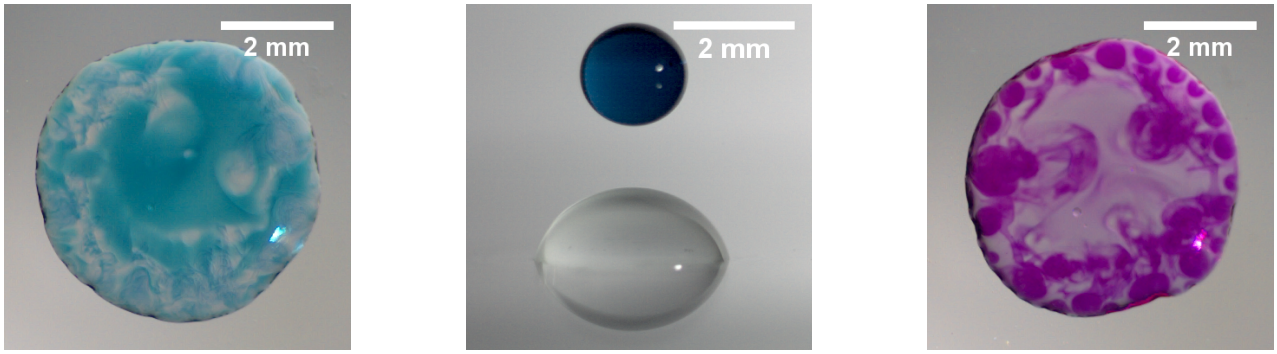
Reactive inkjet printing is an emerging manufacturing technology in which an inkjet printer is used to deposit droplets of different fluids, which coalesce on a substrate and undergo a chemical reaction to form the desired product in situ. For the desired reaction to occur, sufficient mixing between the impacting and coalescing droplets is required, though previous studies have shown surprisingly little mixing between droplets of the same fluid. The purpose of this Short Research Visit (SRV) was to expand on this work by considering coalescing droplets of different fluids, focusing on differences in surface tension where there is an additional contribution to the dynamics from Marangoni flow.

During the four week SRV (14th January to 8th February 2019), an experimental rig was developed at the University of Oxford to study the coalescence between a sessile and an impacting droplet of different fluids. Two colour high speed cameras were used to capture the dynamics simultaneously from the side and below, enabling a more complete understanding of the internal flows than a single viewpoint could offer. Having constructed and improved the rig during the first few weeks of the visit, the remaining time was dedicated to collecting data (over 4 TB in total). The internal dynamics were observed using a passive dye contained within the impacting droplet (left & centre images), or a pH indicator which accentuated the mixed regions (right image).



The results gathered significantly improve the fundamental understanding of passive droplet mixing due to surface tension gradients, with relevance to reactive inkjet printing, whilst exposing new and interesting internal flow phenomena. Abstracts presenting these results have already been submitted to several conferences, and a journal publication is being prepared, with extensive image analysis ongoing. A supporting numerical model is being developed in Leeds to complement and expand upon the exciting experimental results gathered during the SRV. Furthermore, the SRV has successfully strengthened links between Oxford and Leeds, with the 4th meeting of the Drop Dynamics SIG, led by Prof. Castrejón-Pita, being organised in Leeds following discussions during the SRV.

We would like to thank the UK Fluids Network for generously funding this SRV, which generated interesting and important experimental results not realisable without a collaboration of this nature.