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Mathematical modelling for improved control of magnetic particle interfacial assembly[1]

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Recently, microfluidic technologies have facilitated the self-assembly of a variety of particle clusters with enhanced control, at interfaces formed between immiscible liquid phases. In this talk we consider a microfluidic set-up composed of two immiscible fluids. Magnetic particles are inserted into one of the fluids and an applied magnetic field pulls the particles towards the second fluid. The magnetic field is chosen so that individual particles collect at the interface and only aggregates experience a sufficient force to overcome the interfacial tension between the two fluids to be pulled through into the second fluid. We present a mathematical model that captures the aggregation behaviour of the particles both during the approach to the interface and at the interface itself. We uncover the existence of different regimes of behaviour depending on the operating parameters: 'cascading', when individual particles aggregate to form dimers that subsequently aggregate to form 4-mers, 8-mers and so on; and 'hoovering' in which an aggregate is pulled through the fluid and collects individual particles on its way. The results of the model allows for tuning of the magnetic field and interfacial tension to facilitate a route for the formation of aggregates of a desired size.

[1]Royal Society