SIGNALLER AND SEEKER DROPLETS

Wayne Francis, Colm Delaney, Larisa Florea* and Dermot Diamond

Insight Centre for Data Analytics, National Centre for Sensor Research, School of Chemical Sciences, Dublin City University, Dublin, Ireland

Centre for Data Analytics
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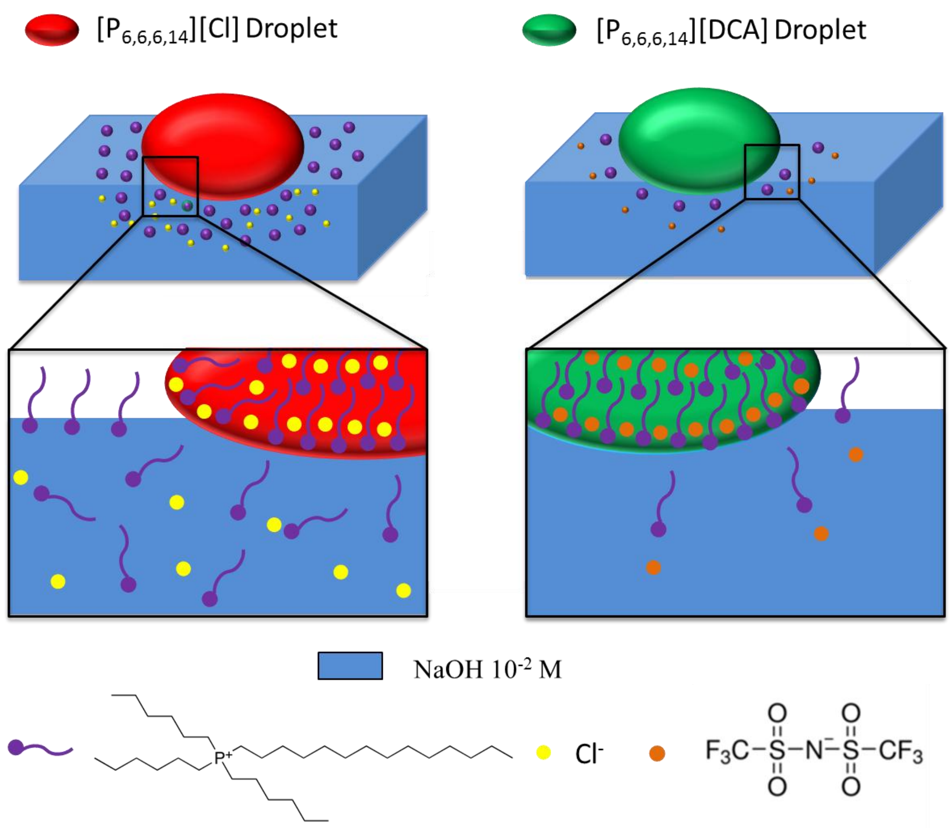
Introduction

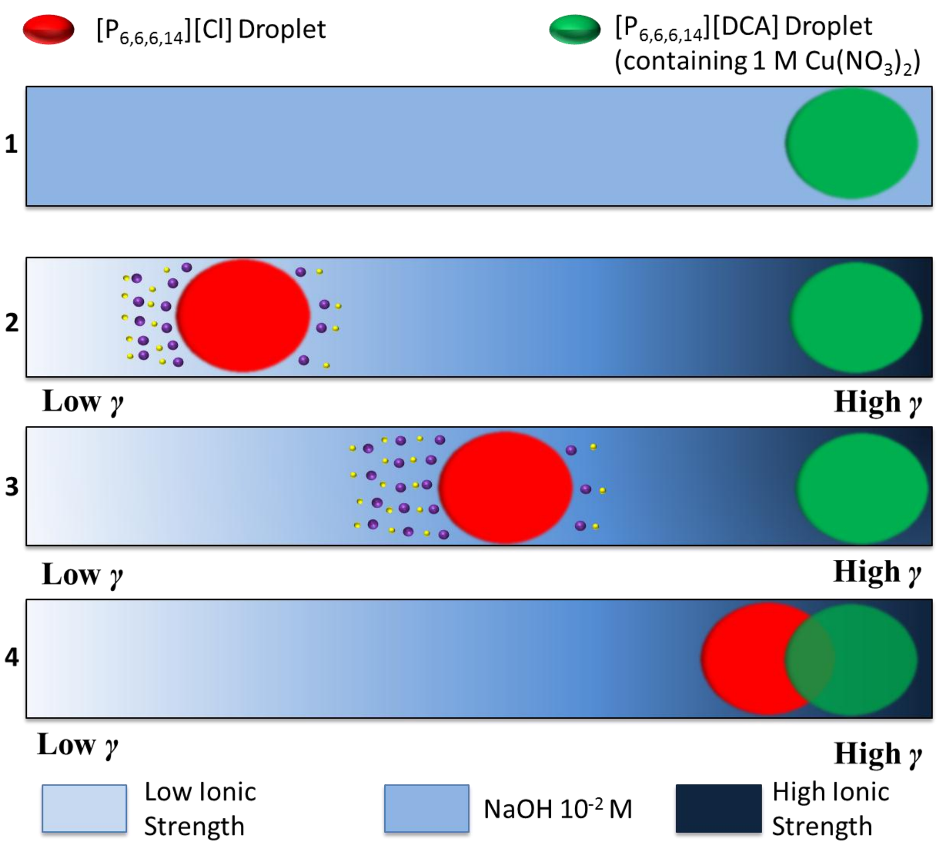
The ability to seek out the source of a chemical signal is vital for many life forms, from single-celled organisms, such as white blood cells (which are able to seek out pathogens due to the chemical messages they release), to complex communities, such as beehives (which require individual units of bees to respond to a chemical signal in order to perform specific tasks). Inspired by these natural examples, herein we have developed signaller and seeker droplets that are capable of finding each other in an open intricate fluidic network.

Droplet Movement and Composition

The droplets in this work are composed of ionic liquids. The signaller droplet is composed of $[P_{6,6,6,14}][DCA]$ containing 1M $Cu(NO_3)_2$, while the seeker droplet is composed of $[P_{6,6,6,14}][Cl]$.

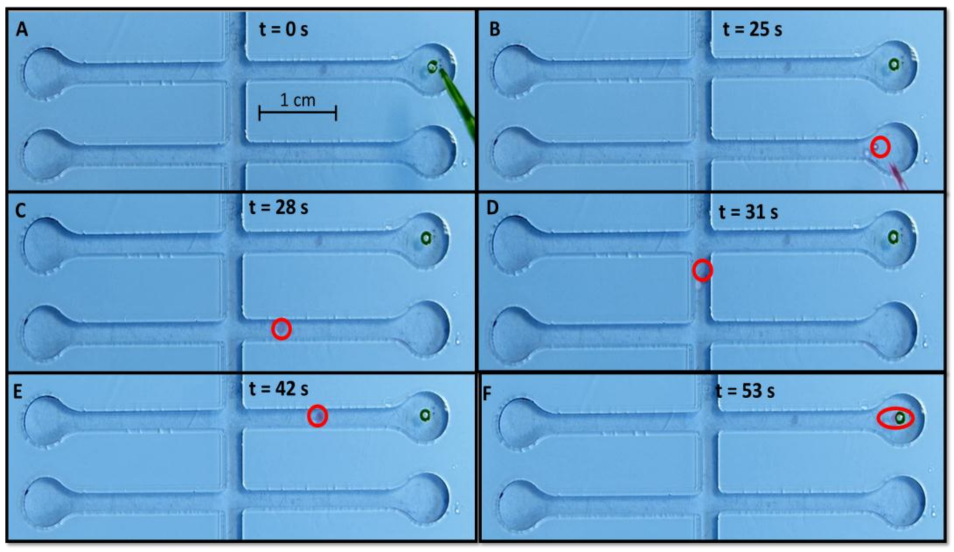


Unidirectional movement of the seeker droplet is due to the triggered release of the $[P_{6,6,6,14}]^+$, a very efficient cationic surfactant, which is a constituent of the IL droplet. In the presence of an ionic strength gradient in the aqueous phase, an asymmetrical surface tension gradient is created, leading to Marangoni like flows, which drive the droplet from areas of low surface tension towards areas of high surface tension. When the signaller droplet is placed onto a solution of 10^{-2} M NaOH, $Cu(NO_3)_2$ diffuses from the droplet into the aqueous phase and creates an ionic strength gradient. Due to the poor solubility of the DCA^- anion, only a small amount of $[P_{6,6,6,14}]^+$ is released from the signal droplet and thus it remains stationary.



Movement Example

Controlled movement of the seeker droplet to the signaller droplet was obtained by first filling the channel with a solution of 10^{-2} M NaOH, followed by placing the signaller droplet at the desired destination. After allowing the ionic strength gradient to form for ~ 20 s, the seeker droplet was placed in the fluidic network. The seeker droplet then autonomously sought out the signaller droplet and merged with it at its stationary location.



Conclusion

We have demonstrated the signalling and seeking behaviour of IL droplets. The seeker droplet moves without any external energy source and can seek and merge with signaller droplets placed at predetermined locations. It is envisioned that these droplets could be used for dynamic sensing, energy free micro-cargo transport and as micro-vessels for chemical reactions.

This project has been funded by Science Foundation Ireland under the Insight initiative, grant SFI/12/RC/2289.

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