ELECTRO-TACTIC IONIC LIQUID DROPLETS

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Data Analytics

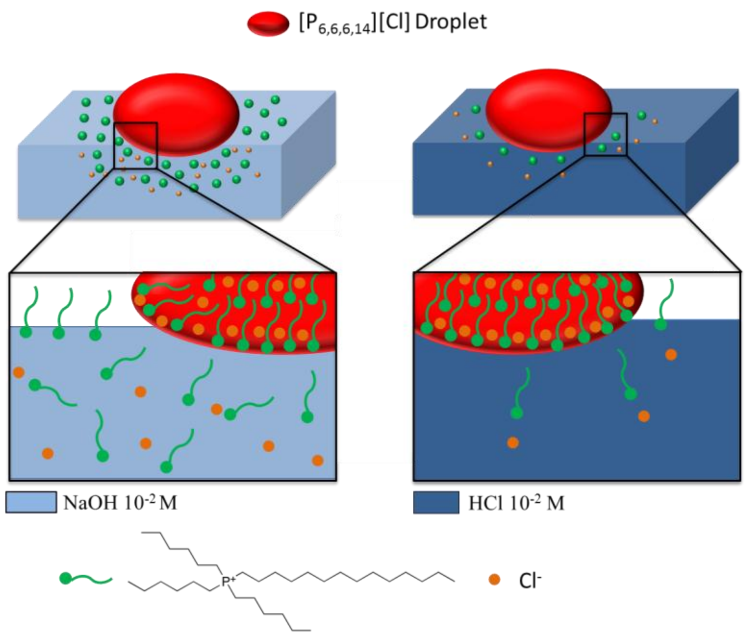
Insight

Introduction

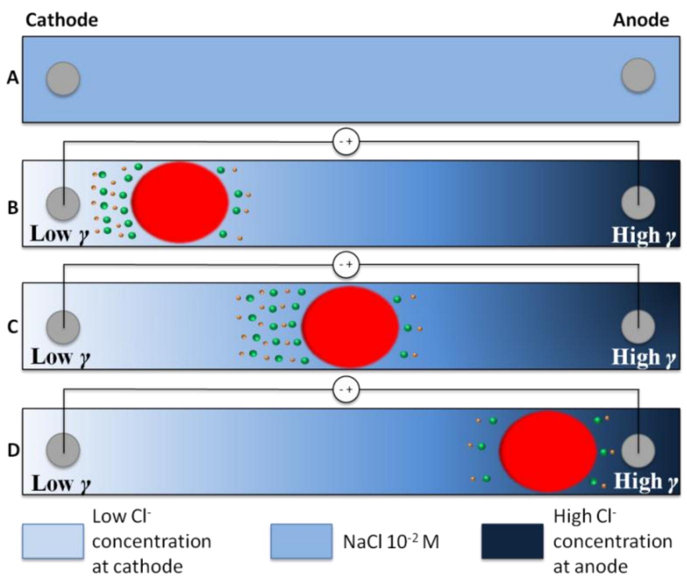
Here we report for the first time electro-guided, self-propelled droplets, which are composed solely of an ionic liquid, namely trihexyl(tetradecyl)phosphonium chloride ($[P_{6,6,6,14}][Cl]$). These self-propelled droplets travel along an aqueous-air boundary and are guided to specific destinations within the fluidic network through the use of electro-chemically generated Cl^- gradients. The direction of movement can be controlled by switching the impressed voltage (9V, ON or OFF) and polarity of the electrodes in contact with the electrolyte solution.

Droplet Movement and Composition

The self-propelled droplets used in this project were designed to move in an open fluidic channel. The movement of the droplet is due to the triggered release of the $[P_{6,6,6,14}]^+$, a very efficient surfactant. On-demand surfactant release has been previously utilised to create chemotactic droplets, which were guided to specific destinations within fluidic channels through chemically generated Cl^- gradients [1].

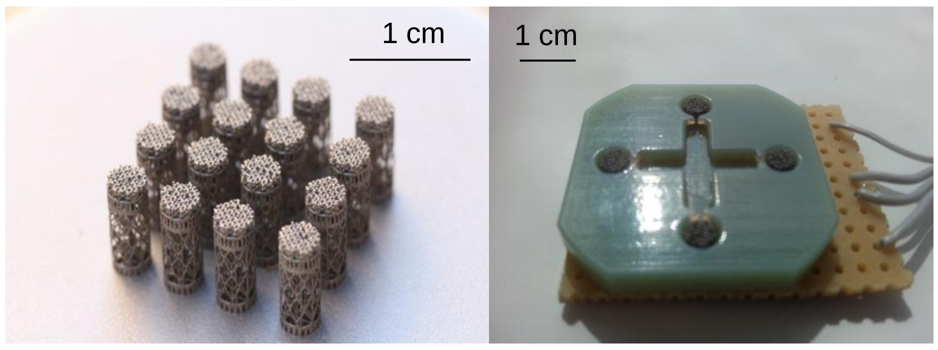


In the presence of an aqueous phase Cl^- gradient, differential release of $[P_{6,6,6,14}]^+$ occurs and a surface tension gradient is created, leading to a Marangoni like flow, which causes the droplet to move from areas of low surface tension towards areas of high surface tension. In this study the Cl^- gradients within the electrolyte solutions were electro-chemically generated.



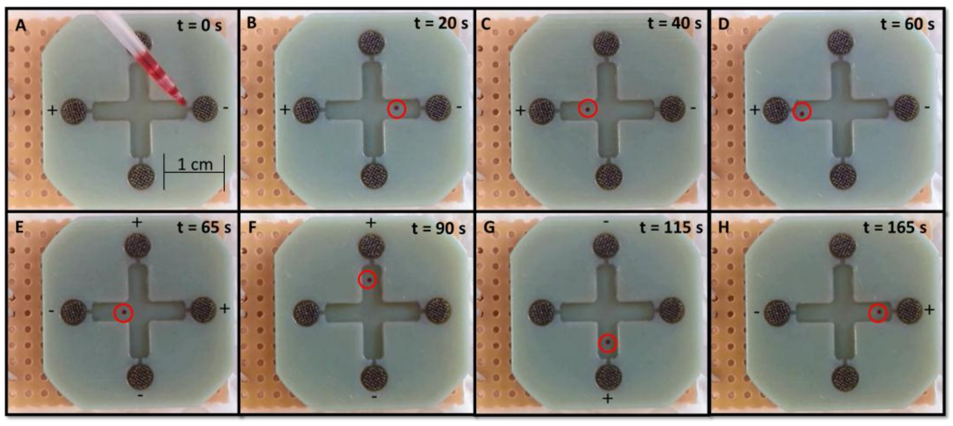
Channel and Electrode Fabrication

The electrodes used in this project were titanium mesh electrodes 3D printed using a Realizer SLM-50 3D printer. The channels were designed in Solid Works and fabricated in ABS Polyjet photopolymer (Stratasys) based on acrylic monomers using an Objet350 Connex 3D printer.



Electro-Tactic Movement Example

To achieve droplet movement, the channels were initially filled with 10^{-3} M NaCl solution and 9 V was then supplied to the electrodes. After 10 – 30 s the droplet was placed at the cathode (-) and spontaneously moved towards the anode (+). The droplets movement was reversed by simply reversing the polarity of the electrodes.



Conclusion

In conclusion, we have reported the electro-tactic movement of a single component IL droplet using electro-chemically generated chloride gradients. This provides a simple means to control the speed and direction of movement of droplets within fluidic channels in a very flexible and low power manner. We envision that these droplets could have numerous applications within the microfluidic sector, including cargo transport to desired destinations, micro-vessels for chemical reactions and dynamic sensing units.

References

[1] Self-propelled chemotactic ionic liquid droplets, W. Francis, C. Fay, L. Florea, D. Diamond, Chemical Communications, **51**, 2015, 2342 – 2344.

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