**DROPLET MICROFLUIDICS**

**Binguan Lu, Alexander Iles and Nicole Pamme**  
*University of Hull, Faculty of Science and Engineering, UK*

**Correspondence:** n.pamme@hull.ac.uk

This work is generously supported by the Ferens Trust

---

**THE ACTIVITY**

Droplet microfluidics has many applications including nanomaterial synthesis, protein crystallisation, single cell studies and digital PCR. Droplets made from suitable precursors can be photo-polymerised to form microgels which in turn can be used in drug delivery. In this outreach activity the generation of droplets within oversized microfluidic devices is demonstrated using fruit juice and sunflower oil.

**AIM**

To demonstrate the use of droplet microfluidics to school children and the general public by:
- producing a safe, interactive experiment to explain droplet generation in microfluidics
- highlighting the applications of the technology.

---

**THE DEVICE**

**HOW IT WORKS**

**Fig. 1:** Schematic of droplet generating devices milled in PMMA with (a) a T-junction and (b) a flow-focussing junction geometry.

**Equipment:** flow-focusing device, syringes with Ribena juice as continuous phase and sunflower oil (with 0.1 wt% Span 80) as dispersed phase

**Attach syringes containing juice and oil to the inlets.

**Push the syringes and observe juice-in-oil droplet generation.**

**Fig. 2:** (a) Students chose a flow-focusing or a T-junction chip to generate water-in-oil droplets. Sunflower oil with a small amount of surfactant (0.1 wt% Span 80) is used as the continuous phase and Ribena juice is used as the dispersed phase. The oil and juice are loaded into plastic syringes. (b) The syringes are pushed into the inlet holes of the PMMA device. (c) By carefully pushing both syringes at the same time, juice droplets surrounded by a continuous oil phase can be produced and observed to flow through a serpentine channel.

**Additional resources for activity to increase understanding and engagement:**

---

**RESEARCH BASIS**

Microfluidic channel networks allow for great control of droplet generation, droplets with precise volumes (from pL to nL) and a narrow size distribution (<5%) can be produced. Droplet microfluidics has been used at the University of Hull for drug delivery from microgel particles. We have generated aqueous droplets containing the gel precursor materials as well as model drugs. Upon photo-polymerisation using 365 nm UV irradiation directly on the serpentine channel in the microfluidic device, the droplets are transformed into amphiphilic microgel particles that swell under certain pH conditions to release both hydrophilic and hydrophobic drugs. The release rate can be controlled by modifying the hydrophobic and hydrophilic precursor components and crosslinking density.

**Fig. 3:** (a) Schematic of droplet generation chip setup with photo-polymerisation, (b) microgel precursor containing droplets generated in a flow-focussing chip, (c) drug release from amphiphilic microgel particles.

---

**KEY REFERENCES**