Manipulating droplets with shaped acoustic fields – applications in medical diagnostics and drug delivery

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Microfluidics and droplet technologies are synonymous with the movement of fluids on or around microstructured surfaces, including channels. Flow is often driven by peristaltic pumps or through electrokinetic flows (including electro-osmosis, for example).

Recently, pressure driven flow through the use of surface acoustic waves (SAWs) has attracted much attention. To better control the nature of the acoustic field when using SAWs, we have introduced the concept of using frequency dependent periodic arrays known as phononic crystals within microfluidics. In doing so, we have enabled new "acoustic holograms" that result in waveguiding, reflectors, bandgaps and lenses, that shape the ultrasonic field and create new microfluidic flows.

We are able to demonstrate how we can create interesting droplet manipulations, including droplet centrifugation, cell lysis through shear in droplets, cell separation, liquid heating and atomization, all on disposable “chips”.

The applications of this technology are demonstrated through three “real-world” examples, namely (i) sample preparation and identification of malarial parasites in blood; (ii) the measurement of visco-elastic properties in small sample in drops and (iii) the control of the size distribution of droplets during nebulization (a requirement in pulmonary drug delivery, for example).