High-Throughput Experimentation Drop-by-Drop

Over the past twenty years there has been a continual and rapid evolution of microfabricated systems for use in the chemical and biological sciences. Interest in microfluidic technology has driven by concomitant advances in the areas of genomics, proteomics, drug discovery, single cell analysis, high-throughput screening and diagnostics, with a clearly defined need to perform rapid measurements on small sample volumes. At a basic level, microfluidic activities have been stimulated by the fact that physical processes can be more easily controlled when instrumental dimensions are reduced to the micron scale.1 The relevance of such technology is significant and characterized by a range of features that accompany system miniaturization. Such features include the ability to process small volumes of fluid, enhanced analytical performance, reduced instrumental footprints, low unit costs, facile integration of functional components within monolithic substrates and the capacity to exploit atypical fluid behaviour to control chemical and biological entities in both time and space. My lecture will discuss why we have been motivated to use microfluidic systems for chemical and biological experimentation and will focus particularly on recent studies that exploit the spontaneous formation of droplets in microfluidic systems to perform a variety of analytical processes. I will provide examples of how droplet-based microfluidic systems can be used to perform a range of experiments including nanomaterial synthesis, cell-based assays and DNA amplification. In addition, I will describe recent studies focused on the development of a novel imaging flow cytometry platform that leverages the integration of inertial microfluidics with stroboscopic illumination to allow for high-resolution imaging of cells at throughputs in excess of 100,000 cells/second.