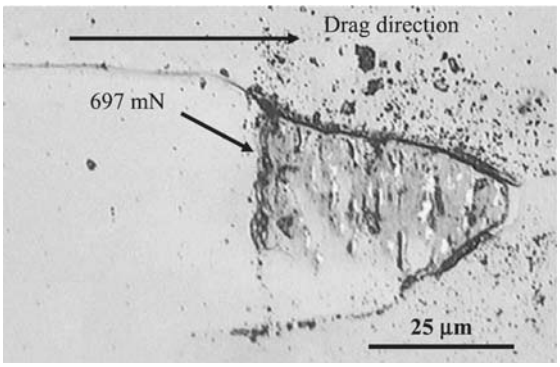


Figure 1. Scanning scratch track showing the "plough-in" effect of the nc-TiC/a-C(Al) coating.

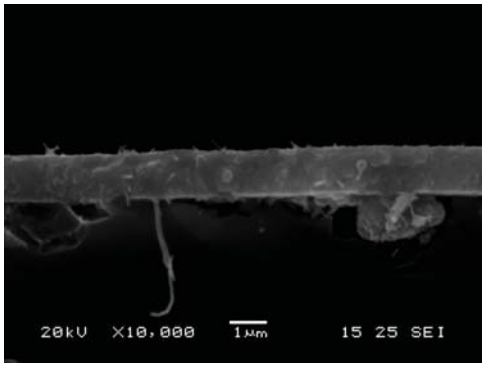


Figure 2. Cross-section SEM of nc-TiC/a-C (CNT) nanocomposite coating. Pull-out fiber-like CNTs can be seen inside the coating

Droplet-Based Micro/Nanofluidics

Investigation on microdroplets promises new design for lab-on-a-chip devices

Droplet-based micro/nanofluidics is a new discipline of the emerging field of microfluidics. In a droplet-based platform, chemical and biochemical reactions are contained inside a small volume. The reactants as well as the reaction products are protected by an immiscible phase surrounding the droplet. Droplet-based micro/nano fluidics needs new concepts for generating, transport, merging, splitting, sorting and switching of the microdroplets.

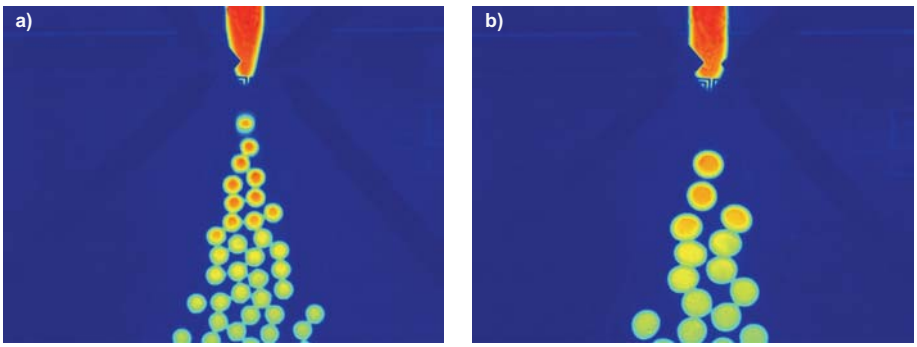


Figure 1. Thermal control of droplet formation: (a) without heating, (b) with heating.

In this A-STAR funded project, a research team consisting of **Assoc Prof Nguyen Nam Trung**, **Assoc Prof Wong Teck Neng** and **Assoc Prof Chai Chee Kiong** from the **School of Mechanical and Aerospace Engineering (MAE)** developed new concepts and devices for manipulating microdroplets and the flow field inside these droplets. The team also set up the experimental facilities for characterizing the flow fields inside a microdroplet. The technology pending a patent promises to lead to a paradigm shift in design lab-on-a-chip devices.

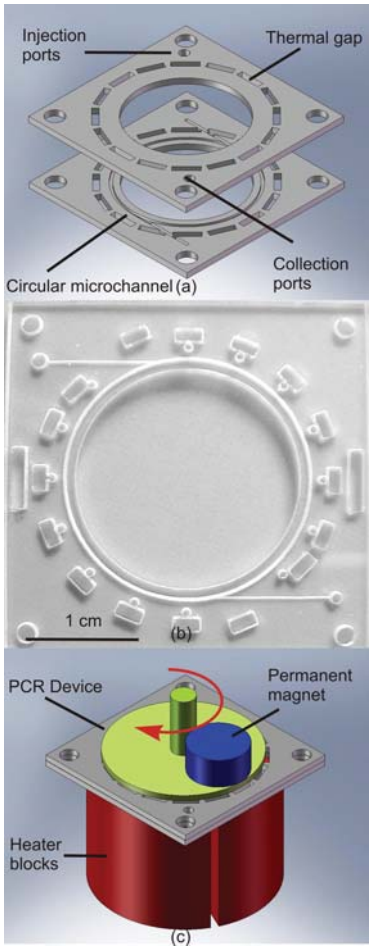
Chemistry and Chemical Engineering

A Magnet-Driven PCR Reactor for DNA Amplification

New efficient and effective technique for chemical and biochemical analysis

Microfluidic is an enabling technology for chemical and biochemical analysis. New microfluidic technologies allow designing better tools for many applications including forensic investigation at crime scenes. DNA can be rapidly and reliably replicated by polymerase chain reaction (PCR). DNA samples are driven by a liquid magnet in a circular closed loop through three different temperature zones.

Completing one loop doubles the amount of DNA in the sample. The miniature PCR device designed by **Assoc Prof Nguyen Nam Trung** from the **School of Mechanical and Aerospace Engineering (MAE)** and **Asst Prof Kwok Yien Chian** from the **National Institute of Education (NIE)** is simpler and more reliable than existing methods because there is no need of micro pumps and other mechanical parts. In this system, the DNA sample is driven by a ferrofluid plug controlled by an external permanent magnet. Successful PCR was achieved in less than 4 minutes. The external magnet is a good way to drive the system as it is low cost, has small power consumption. Current designs commercially available on the market face problems of temperature control, high driving pressures and leakage. The development of the device was funded by NTU and NIE. The work was published in the journal “Lab on a Chip” and highlighted in the magazine “Chemical Technology” in July 2007.



The miniature PCR device is simpler and more reliable than existing methods