Microfluidic devices for biological applications

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INTRODUCTION: Microfluidics is a multi-disciplinary field that deals with the behaviour, control and manipulation of fluids constrained to sub-millilitre volumes. It is proving to be a useful tool for biological studies, affording advantages such as reduced cost, faster reaction times and process-specific designs. A microfluidic system typically consists of a series of channels with components like pumps, valves and actuators to control the flow of fluids[1].

These systems are employed in what is known as "lab-on-chip" devices, where a chip is manufactured to perform a specific chemical reaction or diagnostic test. The chip contains beakers, test tubes, mixers, and particle separators, all on micro scale. A malaria test is transformed from a few-hour, multi-person, resource intensive process to a disposable, easy-to-use process where the only training necessary is the ability to place a drop of blood on a sensor and interpret an intuitive result[2].

A micro-manufacturing facility is being established at the CSIR, Material Science and Manufacturing. The focus is on microfluidics, utilising a soft lithography process. Various components of microfluidic devices have been manufactured and successfully tested. These include valves and mixers. Components that are currently being investigated include emulsion generation devices, particle sorting devices, sensors for measuring flow rate and concentration and variable reaction time circuits.

METHODS: One of the applications being worked on is a microfluidic emulsification device (MES). It will be used to produce monodisperse Spherezyme particles, an enzyme manufacturing process patented by the CSIR. The MES will allow scale-up of the manufacturing process and will significantly reduce the size distribution of the enzynmes. Possible issues which will need to be considered include damage or denaturing of the enzymes during the production process.

Another project deals with designing a microfluidic device to assemble biological nano-machines that convert light energy into mechanical movement. Due to their small size, handling the components and fabricating the nano-machines is a challenging task. A further complication is that the components are required in specified numbers and an established sequence. Self-assembly combined with microfluidics is a promising way to overcome these difficulties.

RESULTS: Proof-of-concept studies have been undertaken on generating emulsions using microfluidic channels. Figure 1 shows an example. The figure shows an emulsion of water and oil. The next steps are to include surfactants, crosslinkers and enzymes and verify the results.

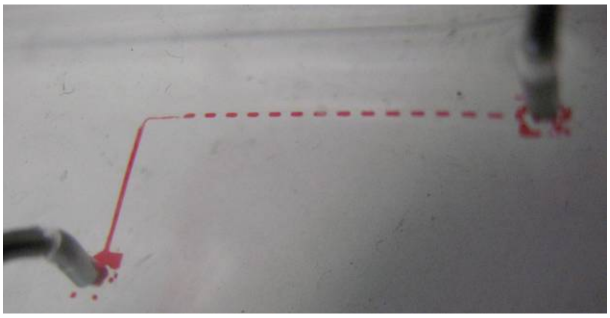

Fig. 1: Emulsion generation using a microfluidic channel.

DISCUSSION & CONCLUSIONS: Microfluidics provides a useful platform for drug delivery, chemical synthesis and medical diagnostics. All indications are that it will play an increasing role in our lives in future – it is believed that microfluidics will solve integration problems in biology and chemistry in the same way that integrated circuits did for microelectronics.

This technology is of critical importance to South Africa, and has resulted in the current effort to introduce the technology and develop the knowledge required to make an impact in the South African economy and health sectors. Furthermore, it is aligned to the national R+D strategy and the Department of Science and Technology's 10 year innovation plan.

REFERENCES: [1] G.M. Whitesides (2006) *Nature* **442**:368-373. [2] C.D. Chin, V. Linder, S.K.Sia (2007) *Lab Chip* **7**:41-57.