TECHNOLOGY LICENSING OPPORTUNITY

NRL Sheath Flow – Microflow Cytometer (MFC)

Compact, robust, low power consumption, high performance cytometer

Background & Technology:

The Naval Research Laboratory (NRL) has pioneered and advanced a technique in controlling flow at the micro-scale: NRL sheath flow. This revolutionary system uses static geometric features to sculpt material distributions. The system utilizes a core stream and one or more sheath streams that are introduced into a single channel. It uses one or more shapes (grooves, chevrons etc.) placed in the top and bottom of the channel. The shape(s) direct the sheath fluid around the core stream, separate the core stream from the walls of the channel and sculpt material distribution (Fig.1). The high flow rate of the sheath fluid compared to the sample stream focuses the sample into a very narrow-diameter core that is exposed to the wider laser beams in the interrogation region of the cytometer (Fig.2).

An exemplar device (depicted in Fig. 3) was used to demonstrate multiplexed detection of bacteria and toxins using fluorescent coded microspheres. Anti-body-coated microspheres bound biothreat targets in a sandwich immunoassay format. The MFC focused the microspheres in three dimensions within the laser interrogation regions using the passive groove structure. Optical analysis at four different wavelengths identified the coded microspheres and quantified target bound by the presence of phycoerythrin tracer. The multiplexed assays in the MFC had performance approaching that of a commercial benchtop unit.

Combining NRL sheath flow designs and integrated waveguides for optical interrogation, NRL has built MFCs for various analytes addressing problems in environmental monitoring to those with clinical interests. One unit characterized and discriminated between populations of phytoplankton and was deployed in an unmanned vehicle. Sheath fluids in NRL MFCs can be recaptured and reused.

Features & Benefits:

- Much more design flexibility & simplicity compared to traditional sheath flow
- Very compact and robust
- Potential risk of clogging is minimized
- Performance approaches commercial benchtops

Status and Opportunity:

- Portfolio of micro-fluidic sensors and peer-reviewed papers
- US Patent 8,361,413 and a suite of related patents available for license; potential collaboration with NRL researchers

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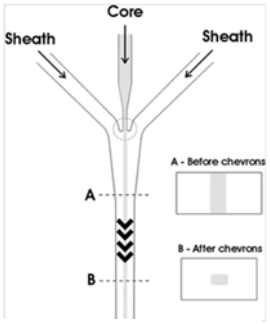

Fig. 1 Core-sheath example

Core fluid is surrounded by sheath fluid by first sandwiching the core between the two sheath streams via fluid focusing.

Chevrons then perform the final sheathing by moving sheath fluid to the top and bottom of the channels.

Size of the core and stream after chevron features depends on the numbers of chevrons and relative flow rates between the core and sheath.

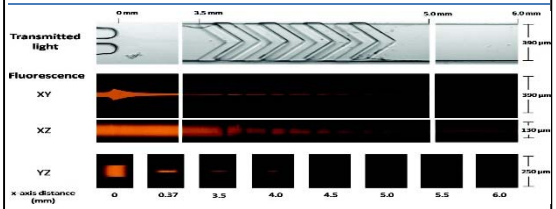

Fig. 2 Images of the sheathing process. Core, with dye, is initially sandwiched between two sheath streams (0 to 3.5mm). Entry into chevrons (3.5 to 5mm), core height is much reduced as sheath surrounds core. Tight core stream enters interrogation zone (6.0mm). Core to sheath velocity in this example is 10 to 400 µL/min.

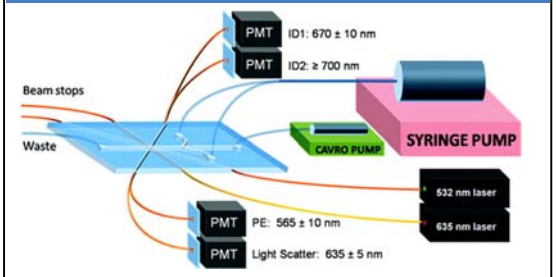

Fig. 3 Example of an NRL microflow cytometer (MFC)

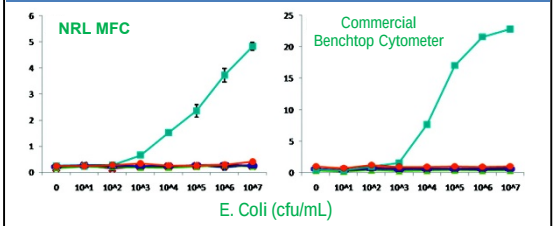

Fig. 4 Multiplex Immunoassays. Abstracted data from dose response curves from a 6-plex assay for 3 bacteria (E. Coli, Listeria, Salmonella) and 3 toxins (cholera, SEB, ricin). Data from the NRL microflow cytometer is compared to an analyses using a commercial benchtop flow cytometer and approaches comparable sensitivity. *Kim, JS et al, 2009. Analyt. Chem., 81, 5426-5432*