In-situ Programmable, Reconfigurable Fluidic Processor for Waterborne Biomolecular Sample Prep: Towards the Development of an Automated Bio-Mass Spec

Brian Gregson, Andrew Farmer, Matt Smith and David Fries,
Center for Ocean Technology, University of South Florida, St. Petersburg, FL

Water toxins produced by cyanobacteria (blue-green algae) are often found as significant contaminants in water supplies. Certain toxins can pose substantial threats to human health and the fisheries industries at exceptionally low concentrations. For example, Microcystis aeruginosa, a globally distributed bloom-forming, toxic cyanobacterium, produces a suite of monocyclic heptapeptide hepatotoxins, known as microcystins - the most important of which is microcystin-LR. Microcystins can be so acutely toxic at low concentrations that the World Health Organization has established the toxic level for drinking and recreational waters to be concentrations greater than 1.0 ug·L-1. Therefore simplified methods to purify, enrich and accurately identify microcystins and other biotoxins at low concentrations are of interest to researchers and officials involved in early detection and monitoring programs.

With the ability to accurately and directly identify individual molecular species with a large mass detection range, time-of-flight mass spectrometry (TOF-MS) is a promising technology for applications involving biotoxin detection. We have made considerable progress investigating technology to simplify the initial sample prep phase of toxin analysis by developing a programmable fluidic processor that can be configured to purify and enrich a wide variety of molecular targets. With regards to microcystin detection, we have taken advantage of antibody-coated surfaces to purify and enrich microcystins from contaminated samples with minimal processing requirements. These surfaces have been prepared on ProteinChip arrays for subsequent analysis on a TOF mass spectrometer.

Our fluidic processor can be combined with antibody recognition surfaces but also can be used directly with other chromatographic surfaces to target a broad range of molecules with various biochemical properties. We anticipate incorporating the automated sample prep module into a proposed field portable mass spec biomolecular analyzer. Such an instrument should prove useful in a wide range of applications including monitoring and research programs requiring near real-time detection and identification of waterborne biomolecular targets.