Automated Microfluidic Array for Multiple Proteins using Electrochemiluminescent Detection

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Measuring panels of multiple proteins in serum holds great promise for personalized cancer diagnostics. Broad realization of such diagnostic strategies has yet to be achieved due to lack of inexpensive, sensitive devices to measure multiple proteins, and lack of fully validated panels. For clinical or point-of-care (POC) use, automation of protocols and low cost are essential. This paper describes a prototype modular microfluidic system capable of ultrasensitive automated detection of multiple serum proteins with electrochemiluminescence (ECL) detection.

We designed an automated reagent and sample delivery module featuring 6 microfluidic channels interfaced with a SWCNT immunosensor detection chip. Detection is amplified by using RuBPy embedded into 100 nm silica nanoparticles and coated with antibodies to provide low fg/mL detection using a CCD camera. The entire device costs ~€500, excluding the CCD camera. Microwells were fabricated on the PG chip using a print/heat/peel technology. Integrated micropumps, one per channel, were connected to the sample/reagent cassette preloaded with serum samples, wash buffers and dye-silica nanoparticles in the sequence needed for the assay. These air-separated solutions are pumped into the six-channel measurement chamber chip with SWCNT wells containing capture antibody under control of an open-source electronics prototyping interface (Arduino). This microcontroller facilitates fully automated control of flow and incubation times. A panel of 4 oral cancer biomarkers was measured in serum samples at clinical levels using this approach.