Microfluidic Devices for Detecting Biomarkers Related to Disease

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My research group is developing microfluidic systems that can be used to diagnose medical conditions, including sepsis and risk for preterm birth (PTB). We hot emboss microdevices for sepsis detection in black polypropylene, forming the fluidic structures by thermally laminating a clear polypropylene layer on the imprinted structures. We use oligonucleotide-functionalized porous polymer monoliths or magnetic microbeads in these microdevices to capture, fluorescently label, and elute target DNA from complex mixtures. We have obtained DNA recovery values greater than 80% in these systems [1]; recently, we demonstrated a single-step approach for making DNA-linked monoliths that selectively capture target DNA [2]. We are currently utilizing our columns on bacteria isolated from blood and lysed, and then directing the eluted nucleic acids to a single-particle counting detector in an optofluidic device.

We have also developed planar micromachining and soft lithography to make microfluidic devices with pumps, valves and monoliths for automated analysis of maternal blood serum peptides and proteins related to PTB risk [3]. Moreover, we have utilized microchip electrophoresis, optimized separation parameters, and measured detection limits for many PTB biomarkers in planar micromachined systems [4]. To facilitate fabrication we are 3D printing microfluidic devices [5] with a stereolithographic 3D printer that makes microstructures as small as 20x20 µm² [6-8]. We are now using 3D printed microfluidic devices for on-chip PTB biomarker sample preparation and analysis [9]. The methods for device construction and microfluidic systems we are developing have excellent possibilities for advancing rapid disease diagnosis.

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References