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Title: Melting Agarose Beads for Enhanced Optical Detection

Rapid diagnostic platforms have become increasingly necessary to address global disease outbreaks, make informed timely medical decisions, and meet the needs of resource-poor regions. Current diagnostic technology is cost prohibitive for point of care, requiring all samples to be sent to a centralized lab for analysis, which can delay results from several hours to a week. Researchers have attempted to address this issue through the development of microfluidic diagnostics that detect a variety of biomarkers. Many of these tests, however, use two-dimensional surfaces to immobilize target biomarkers, limiting detection performance. Using a three-dimensional biomarker capture matrix will increase the amount of sample fluid in contact with an activated surface by an order of magnitude. This increased contact generates faster, more reliable, and more accurate diagnostic tests due to the increased target capture efficiency and reduced diffusion distance. Three-dimensional matrices have been considered impractical due to the highly opaque nature of the matrix. I have demonstrated a simple detection method using 20µm diameter low melting point (LMP) agarose beads as a novel three-dimensional matrix. The beads can be activated to create an exposed biotin group, which can be further activated for ELISA. While conducting the assay, the agarose beads are nearly opaque; however, once the target biomarkers have been immobilized on the bead matrix, the beads can be melted into a solid mass, reducing light scattering and improving optical clarity for high diagnostic performance. To produce these beads at sufficient scale and throughput, I developed a Raspberry Pi-controlled microfluidic device to automate a repeatable and scalable production method. To demonstrate how this technology could be utilized for diagnostic purposes, I developed a low cost optical detection system that could rapidly analyze a direct assay. With additional research, these two devices can be optimized for clinical applications such as tracking the spread of Ebola, Zika virus, or future outbreaks.