Paper-Based Digital Microfluidic Chip for Multiple Electrochemical Assay Operated by a Wireless Portable Control System

The printing and modular fabrication of a paper-based active microfluidic lab on a chip implemented with electrochemical sensors (ECSs) is developed and integrated on a portable electrical control system. The electrodes of a chip plate for active electrowetting actuation of digital drops and an ECS for multiple analysis assays are fabricated by affordable printing techniques. For enhanced sensitivity of the sensor, the working electrode is modified through the electrochemical method, namely by reducing graphene with voltammetry and coating gold nanoparticles by amperometry. Detachable sensor and absorber modules are assembled modularly on an open chip plate, forming various novel hybridized open–closed chip formats. By varying the coupled or decoupled sensor modules, excellent detection of three diagnostic biological molecules is demonstrated (glucose, dopamine, and uric acid in human serum). With a newly designed portable power supply and wireless control system, the active paper-based chip platform can be utilized as an advanced point-of-care device for multiple assays in digital microfluidics.

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