A DNA biochip for on-the-spot multiplexed pathogen identification

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Abstract: Miniaturized integrated DNA analysis systems have largely been based on a multi-chamber design with microfluidic control to process the sample sequentially from one module to another. This microchip design in connection with optics involved hinders the deployment of this technology for point-of-care applications. In this work, we demonstrate the implementation of sample preparation, DNA amplification, and electrochemical detection in a single silicon and glass-based microchamber and its application for the multiplexed detection of Escherichia coli and Bacillus subtilis cells. The microdevice has a thin-film heater and temperature sensor patterned on the silicon substrate. An array of indium tin oxide (ITO) electrodes was constructed within the microchamber as the transduction element. Oligonucleotide probes specific to the target amplicons are individually positioned at each ITO surface by electrochemical copolymerization of pyrrole and pyrrole-probe conjugate. These immobilized probes were stable to the thermal cycling process and were highly selective. The DNA-based identification of the two model pathogens involved a number of steps including a thermal lysis step, magnetic particle-based isolation of the target genomes, asymmetric PCR, and electrochemical sequence-specific detection using silver-enhanced gold nanoparticles. The microchamber platform described here offers a cost-effective and sample-to-answer technology for on-site monitoring of multiple pathogens.

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