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DEVELOPMENT OF AN ELECTROWETTING VALVE IN CAPILLARY-DRIVEN MICROFLUIDIC BIOSENSOR FOR NUCLEIC ACID DETECTION

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This article presents the development of microfluidic valves to be used in capillary flow microfluidic device as a platform for nucleic acid detection. The valve used the principle of electrowetting and was able to be actuated at low voltage. The valve consisted of two silver electrodes which were encountered in series within a microfluidic channel. The second electrode was modified with a hydrophobic monolayer resulting in a cessation of capillary flow. A potential of 4V resulted in a 70° reduction in water contact angle within ten seconds which allowed capillary flow to continue. The final device represented a microfluidic valve for capillary flow microfluidics realized on PMMA substrate.

In addition to the valve designed for timed fluid delivery, our PMMA microfluidic chip also consists of self-priming microfluidics with sealed conjugate pads of reagent delivery and an absorbent pad for additional fluid draw. We have developed a single-step surface modification method which allows strong capillary flow within a sealed microchannel. Conjugate pads within the device held trapped complex consisting of the magnetic beads and nucleic-acid-probe-conjugated horseradish peroxidase (HRP). Magnetic beads were released when sample entered the chamber and hybridized with the complex. The complex was immobilized over a magnet in the capture zone while a luminol co-reactant stream containing H₂O₂ was merged with the channel. A photomultiplier tube was used to quantify the chemiluminescence signal.

This new format of biosensor will not only allow for pumpless automatically reagent delivery, but also smaller and more sensitive detection, as well as commercial-scale manufacturing and low materials cost, and it would be an ideal device for fast diagnostic in resource-limited settings.