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Development and surface characterization of an electrowetting valve for capillary-driven microfluidics

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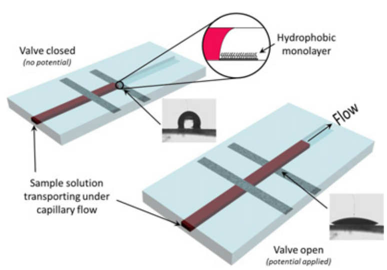
HIGHLIGHTS

- ► An electrowetting valve for capillary flow microfluidics is proposed.
- ► The analysis of hydrophobic monolayers on printed silver electrodes was performed.
- ► Low voltage electrowetting was conducted on the printed electrodes.
- ► The chemical composition of the valve before and after actuation was determined.
- ► The valve was tested in a flexible microfluidic device with printed electrodes.

GRAPHICAL ABSTRACT



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ABSTRACT

This article presents the development of a microfluidic valve to be used in capillary flow microfluidic devices. The valve used the principle of electrowetting and was able to be actuated at low voltage. The valve consisted of two inkjet-printed 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 4 V resulted in a 70° reduction in apparent water contact angle within 10 s which allowed capillary flow to continue. The electrode surface chemistry was investigated prior to monolayer deposition, after monolayer deposition and following the application of the 4 V potential. The flexible microfluidic channel consisted of two layers of polyethylene terephthalate bonded by a pressure sensitive adhesive layer which was patterned with a laser ablated microfluidic channel. The final device represented a microfluidic valve for capillary flow microfluidics realized on a flexible substrate. The valve was designed to allow timed fluid delivery for low-cost lab-on-a-chip applications.

1. Introduction

In addition to cost, a major limitation of current microfluidics for disease diagnostics is complexity. Specifically, many microfluidic biosensors, while highly specific and sensitive, require additional peripheral lab equipment to operate, thus limiting their true portability and utility in resource limited settings such as on-farm point-of-care settings. In order to transport fluids within a chip, microfluidics often require an external pumping mechanism such as a syringe pump [1,2], peristaltic pump [3] or pneumatic pump [4]. These pumping methods result in a considerable increase in the final size of the detection device. Therefore, significant efforts have been made to find an alternative method for fluid transport such as the use of electroosmotic flow [5–7] which uses a high voltage source for fluid transport similar to electrophoresis. Unfortunately,

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