RAPID DEVELOPMENT OF PAPER-BASED FLUIDIC DIAGNOSTIC DEVICES

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Abstract

We present a method for rapid and low-cost development of microfluidic diagnostic devices using paper-based techniques. Specifically, the implementation of fluidic flow paths and electronics on paper are demonstrated, with the goal of producing an integrated functional diagnostic device manufactured on paper. There is an increasing demand to provide portable, robust and rapid diagnostics at the point of care, especially in poorly resourced areas where factors such as cost, power and lack of skills are major issues. Paper-based microfluidics offers solutions to address these challenges, largely as a result of the low-cost and straightforward manufacturing techniques [1]. Printed electronics is a growing field, poised to significantly contribute to accessible diagnostics [2]. Combining microfluidics and electronics on paper enables novel devices to be realized, since components such as diagnostic result readout can be integrated on a disposable, low-cost and readily available platform. We explore two important components for realizing a functional paper diagnostic device: 1) fluidic flow functionality using wax barriers, and 2) detection methods via the implementation of electronics. We illustrate that these components can be realized either by using very simple, low-cost and manual methods or through sophisticated fabrication techniques utilizing specialized printing equipment for depositing various functional fluid materials such as wax and conductive inks with fine resolution. The results show that both techniques can create functional paper-based components, including multiplexed fluidic flow paths, as well as electronics on paper, and show that these can be integrated into a functional device. The use of accessible materials to create functional devices makes this technology ideal for rapid prototyping of design ideas and for educational purposes. This also serves to create an awareness of the possibilities of this technology to spur interest and innovation in the field of paper-based diagnostics. Existing facilities in South Africa, such as the FabLabs (www.fablab.co.za), are ideal for the manufacture of paper prototypes and small-scale production of the devices and provide a ready source of device testers. For mass production, existing roll-to-roll manufacturing techniques could be employed to print the paper devices.