Wax Screen Printed Fabric-Based Colorimetric Microfluidic Wearable (Bio)Sensors for Biomarkers in Sweat

Mamas I. Prodromidis
Laboratory of Analytical Chemistry, University of Ioannina, 45 110 Ioannina, Greece
mprodrom@uoi.gr

Wearable sensors for healthcare monitoring offer a non-invasive, real-time analysis of biological samples. Fabric (cloth) is a very promising material for the development of wearable (bio)sensors due to its low cost, ability to transport fluid via capillary forces, flexibility, high tensile strength and durability, and biocompatibility. Hence, cloth is an ideal material for the development of economical and user-friendly diagnostic devices. The fabrication of cloth-based microfluidics has been implemented with various methods, such as weaving, wax-transfer printing, manual rubbering with solid wax through a screen, paper-aided wax printing, photolithography and stitching.

Here, we present the formulation of a screen-printing compatible wax-based thixotropic ink and the fabrication of low-cost microfluidics based ink on a 95:5 cotton:elastane cloth with an automatic, high throughput screen printing technique.

We have developed colorimetric wearable fabric-based (bio)sensors for the determination of different biomarkers in sweat. Sweat chloride, urea and pH are essential biomarkers, since they constitute indicators for cystic fibrosis, kidneys' malfunction, and dehydration. Research on the wax-based ink composition was accomplished by preparing inks in different solvents, thixotropic polymer solutions, and wax types and quantities.

Sweat analytes were determined taken as a measure the change in the RGB color intensity and the L*a*b* color coordinate system of the assay zones. The proposed colorimetric procedure for the determination of chloride ions depends on the chemical reaction between the chloride ions and silver chromate that causes the discoloration of silver chromate. The detection range was 20-80 mmol/L chloride which covers the normal range of chloride ions in sweat. For the determination of urea and pH, a shared approach was followed, based on the color change of a pH indicators blend. In the case of urea, enzymatically produced ammonia, due to the hydrolysis of urea in presence of urease, causes pH changes that relate linearly with the concentration of urea in sweat. The color was measured by using the mobile app ColorGrab, that obtains live responses from the RGB channels, or by the color analysis of images obtained by a scanner or a mobile phone using the open access software ImageJ.

Our future goal is to expand the application of our fabric-based wearable biosensors at other important biomarkers, thus enabling health experts and untrained users to monitor and manage health issues in a facile way outside the laboratory.

Figure 1: Wax screen-printed fabric-based colorimetric microfluidic device.