Wearable gravimetric sensor based on hydrogel for pH sweat levels monitoring at nL scale

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Abstract

Sweat pH is one of most important parameter commonly utilized, for example, to describe hydration status of athletes [1]. Currently wearable device present in literature are based on colorimetric and electrochemical sensors [1, 2]. In this work we present a flexible gravimetric device for sweat pH monitoring as new kind of wearable device. Here, we show the integration of pH responsive (CEA/PEGDA 10kDa) hydrogel photopatternated onto free standing AlN membranes [3]. The lithography process is sketched in figure 1: pre-polymer solution, consisting of CEA/PEG-DA 10kDa and Irgacure®819, was spun onto AlN membranes with silane pre-treated surface, and proximity photolithography was performed by mask aligner (SussMicrotecTM). The final device is show in figure 2. The hydrogel geometrical variations were studied through confocal microscopy acquisition. In particular Figure 3a and 3b show shrunk (at pH 3) and swelled hydrogel (at pH 8), respectively. Laser Doppler Vibrometry (LDV) was utilized to study the free standing AlN membrane as a gravimetric flexible sensor, in which the mass changes according to the hydrogel water absorption condition. The frequency sweep was obtained by directly driving the piezoelectric transducers. Experimental spectra (displacement vs frequency) are reported in figure 4 for dry (dotted line) and wetted (solid line) hydrogel. The frequency shift from 180 kHz to 160 kHz showed in figure 4 is due to hydrogel weight changes before and after water absorption of approximately 0.3 nL. Selective swelling at different pH conditions of sweat can therefore be measured directly as a frequency shift in this frequency range. We believe the combination of pH sensitive hydrogel and flexible piezoelectric membrane is a promising technology for the development of wearable, innovative and cheap devices for pH sweat monitoring.

References

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[2] Koh, *et al.,* Sci Transl Med (2016) 8,. 366ra165.
[3] Mastronardi V. M. *et al*., Appl. Phys. Lett. (2015) 106, 162901.

Figures

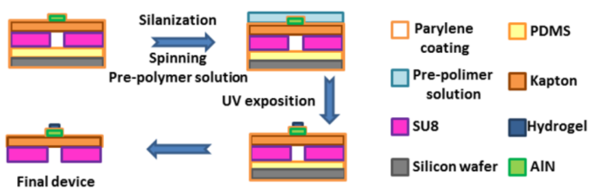

Figure 1. Hydrogel patterning flow process onto AlN membrane.

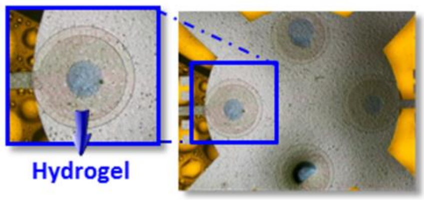

Figure 2. Top view optical image of the free standing membrane surmounted by cylindrical hydrogel.

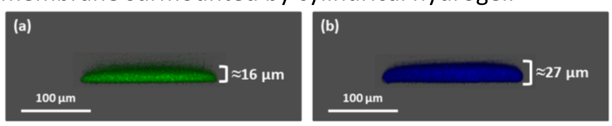

Figure 3. Side view confocal image of shrunk (a) and swelled (b) hydrogel when soaked with pH 3 and 8 solution, respectively

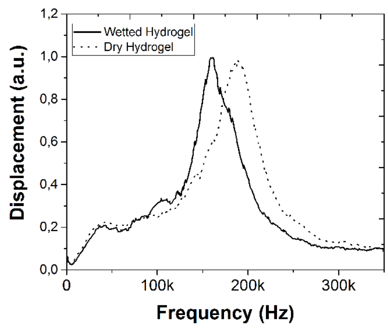

Figure 4. Resonance frequency shift of the free standing membrane due to hydrogel mass changes