DEVELOPMENT OF HYDROGEL MEMBRANES FOR LONG TERM BIOPOTENTIAL MONITORING USING FLEXIBLE WET ELECTRODES

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Abstract

Ubiquitous monitoring of biopotentials can greatly enhance comfort, health and safety of patients dealing with chronic diseases. For home use, clinical grade adhesive electrodes are often cited as irritating and uncomfortable, leading to low usage compliance [1]. For long-term monitoring it is mandatory to have innocuous and disposable electrodes with constant impedance over long periods of time.

In previous work we developed 100% dry electrodes to fabricate a T-shirt for long-term ECG monitoring [2]. These dry electrodes exhibit low stability: they change their impedance over length of use and may even vary within a single ECG register. We concluded that dry electrodes can´t bring enough stability and thus electrodes with interfacial wet membranes are preferred.

In the current work we present the development, fabrication and characterization of wet bioelectrodes for long-term biopotential monitoring. The new printed and textile-based electrodes allow carrying out long-term recordings due to their biocompatibility (non-toxic, non-allergic and non-irritant). However, they present high electrode-tissue interface impedance, providing a low level signal with clear motion artifacts that can´t be digitally filtered without losing valuable information. To improve the signal quality, a non-irritating hydrogel membrane which improves the contact impedance and reduces the movement artifact is being developed.

Apart from biocompatibility, the developed membranes must satisfy two basic requirements: good mechanical adhesion to the skin of the patient and interfacial impedance equal or lower than conventional ECG electrodes. We are studying two different hydrogel formulations based on acrylamide polymers on one hand and polyvinylpyrrolidone (NVP) on the other hand. Apart from the hydrogel formulation, we focused our attention in the mechanical behavior of the membranes. In order to improve their mechanical stability we propose the use of embedded tissue that strengthens the hydrogel membrane without losing flexibility. A wide variety of tissues were tested, being XXX and XXX the ones that showed best compatibility into the membrane. Pictures of tissue embedded membranes are shown in Figure 1.

Relative impedance measurements between commercial ECG electrodes and textile electrodes with different formulations of interfacial membranes are shown in Figure 2. The impedance of the textile electrodes remain below the measured impedance for commercial ECG electrodes independently of the NVP formulation membrane.

We have proved that hydrogel-based interfacial membranes can be used in combination with textile electrodes for long term ECG monitoring. The developed solution provides good functional behavior in terms of stability, mechanical adhesion and conductivity. These membranes are actually being tested in T-shirt prototypes with integrated textile sensors which are expected to allow for comfortable ubiquitous ECG monitoring. The final product is a T-shirt where the electrodes will do the register in continuous.
The T-shirt has 4 different register points, two on the front of the T-shirt and the others two on the back.

In Figure 3 we present one prototype of the T-shirt with textile ECG electrodes.

References

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Figures

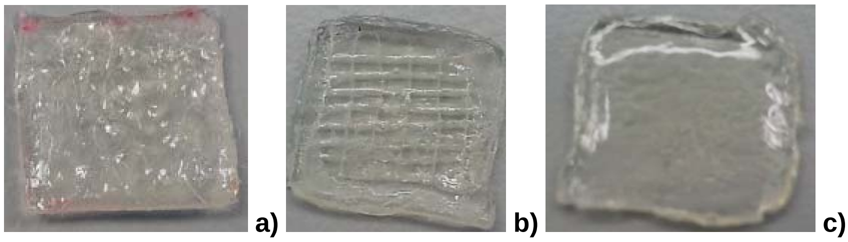

Figure 1: a) hydrogel membrane with synthetic wadding. b) hydrogel membrane with web cotton c) hydrogel membrane with silk.

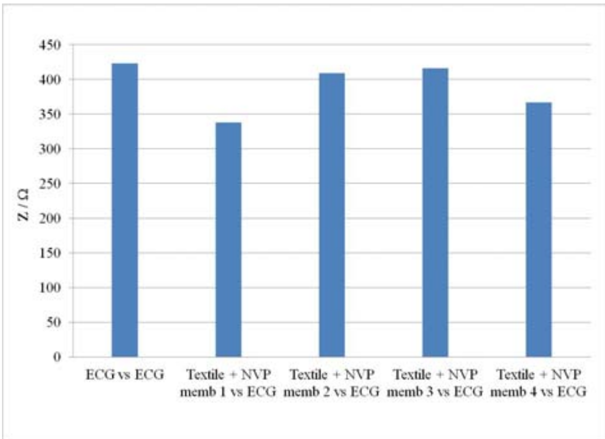

Figure 2: Impedance register of different ECG electrodes, referenced to ECG commercials.

Figure 3: View of different parts of developed T-shirt to biopotencials registers.