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Novel approaches for the development of high performing epidermal devices

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Epidermal electronics is new application field in which highly flexible devices can be transferred in intimate contact with the skin and employed for the monitoring of different bio/physical parameters. This technology has huge applicative potential in biomedicine as the substantial imperceptible nature of these systems allow in principle to dramatically improve the patient's comfort in long term monitoring of important biosignals, as for instance ECG, EEG, EMG, etc

Organic Bioelectronics may add an important contribution to this kind of applications due to the versatility of materials and devices allowing the development of novel sensing abilities to epidermal systems.

In order to fully express this potential, it is however necessary to address some important challenges inherently connected with concrete applications of epidermal electronic systems. First, it is necessary to develop a device architecture that can well adapt to mechanical properties of the human skin, but also a procedure that allows such devices to be transferred in a reliable way, still preserving their performances. Second, for long term monitoring, such structures must be breathable, in order to avoid skin irritation and lack of signal stability. Third, the epidermal system must be connected, in the majority of cases, with an external readout system (for instance a clinical grade cardiographic unit) and this connection results to be the weakest point of the whole system, due to the normally huge mechanical mismatch between the epidermal device and the connections. All these challenges need to be tackled without significantly compromising the complexity of the fabrication procedure, in order to preserve the low cost of these systems that are typically intended as disposable. In this presentation we show tattoo-like electronic systems, aimed at solving some of the most compelling applicative needs of this technology, that can be easily fabricated on submicrometer-thick plastic substrates and employed for the reliable short- and long-term monitoring of different bio-signals [1].

We will show several kinds of systems, spanning from systems assembled on top of parylene C transpirable substrates [2], to free-standing electrodes able to magnetically connect with external connectors [3]. We will discuss the different fabrication issues and report about the results we have recently obtained by using such systems in different application scenarios as the recording of electrocardiographic and electro-miographic signals, showing very good performances if compared to commercial electrodes.

References

[1] A. Spanu, A. Botter, A. Zedda, G. L. Cerone, A. Bonfiglio, D. Pani, "Dynamic surface electromyography using stretchable screen-printed textile electrodes", IEEE Trans Neural Syst Rehabil Eng. 2021;29:1661-1668. doi: 10.1109/TNSRE.2021.3104972.

[2] Spanu, Andrea. Mascia, Antonello, Baldazzi, Giulia, ;Fenech-Salerno, Benjic, Torrisi, Felice, Viola, Graziana, Bonfiglio, Annalisaa, Cosseddu, Piero, Pani, Danilo, "Parylene C-Based, Breathable Tattoo Electrodes for High-Quality Bio-Potential Measurements", Frontiers in Bioengineering and Biotechnology, Open AccessVolume 1023 March 2022 Article number 820217, doi: 10.3389/fbioe.2022.820217

[3] Andrea Spanu, Mohamad Taki, Giulia Baldazzi, Antonello Mascia, ,Piero Cosseddu, Danilo Pani, Annalisa Bonfiglio, "Epidermal Electrodes with Ferrimagnetic/Conductive Properties for Biopotential Recordings", Bioengineering 2022, 9(5), 205; doi: 10.3390/bioengineering9050205