Lab-On-Fiber: Wearable Multi-Sensing Device Enabling the Assessment of Wound Healing

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Chronic wounds such as venous and diabetic foot ulcers affect 1-2 % of the population and represent 2-4 % of healthcare expenses. Management of chronic and acute wounds remains challenging: available methods based on visual signs and symptoms provide limited accuracy and strongly rely on the practitioner's experience. Moreover, wound care technologies lack sufficient evidence of their impact to objectively support their utilization.
We designed a non-invasive lab-on-fiber multi-sensing device for monitoring physiological parameters in wound exudate that are relevant to evaluate the healing process, such as the pH level and the concentration of glucose and proteinase[1]. Each of the three polymeric optical fibers (POF) forming the device was functionalized with specifically designed fluorescent-based sensing chemistries for the targeted analytes. Whereas the fabrication of pH-sensitive fiber was relatively straightforward, the preparation of glucose and proteinase-sensitive fibers required firstly the design of suitable fluorescence-based detecting methods[2] which were then used to functionalize POFs. The detection sensitivity and selectivity was determined for each fiber confirming their suitability for monitoring pH, glucose, and proteinase in the ranges relevant to the wound environment. As expected the use of POF allowed to increase the detection sensitivity for both glucose and proteinase detection of respectively 5.9 and 2.6 times. The selectivity and robustness of the multi-sensing device were confirmed by testing it with complex solutions having different pH (5, 6, and 7) and different concentrations of glucose (1.25, 2.5, and 5 mM) and MMP (1.25, 2.5, and 5 µg/mL). Further studies are planned to evaluate the stability of the sensing chemistries over time and to test the efficacy of the proposed device using wound exudate samples from hospitalized patients. The simple set-up of the multi-sensing POF-based devices is versatile and can be further implemented to detect other parameters that are relevant for the rapid and accurate assessment of wound healing (e.g. uric acid, bacteria). We believe that such a simple set-up and the sensing chemistries proposed in this work could represent a game changer in the non-invasive management of wounds.

References

[1] G. Giovannini, K. Sharma, L. F. Boesel, R. M. Rossi. Lab-On-A-Fiber Wearable Sensor Enabling the Assessment of Wound Healing by Monitor Multiple Physiological Parameters. Advanced Healthcare Materials. *Submitted*.
[2] G. Giovannini*, L. F. Boesel, and R. M. Rossi*. Thioflavin-modified molecularly imprinted hydrogel for fluorescent-based non-enzymatic glucose detection in wound exudate. Materials Today Bio, 2022, 14, 100258