O4 SB2

MINIMALLY-INVASIVE MICRONEEDLE-BASED BIOSENSOR ARRAY FOR TRANSDERMAL SIMULTANEOUS LACTATE AND GLUCOSE MONITORING

P. Bollella[1], S. Sharma[2], A.E.G. Cass[3], R. Antiochia[1]

[1]*Department of Chemistry and Drug Technologies, Sapienza University of Rome, Rome, Italy*
[2]*College of Engineering, Swansea University, Swansea, Wales*
[3]*Department of Chemistry & Institute of Biomedical Engineering, Imperial College, London, UK*

Microneedle arrays for minimally invasive continuous sensing in the dermal interstitial fluid (ISF) have been demonstrated in both amperometric [1,2] and potentiometric [3] modes, however there are no publication where microneedle arrays have been shown to function as second generation biosensors [4]. Here we report the first mediated pain free microneedle-based biosensor array for the continuous and simultaneous monitoring of lactate and glucose in artificial interstitial fluid (ISF).

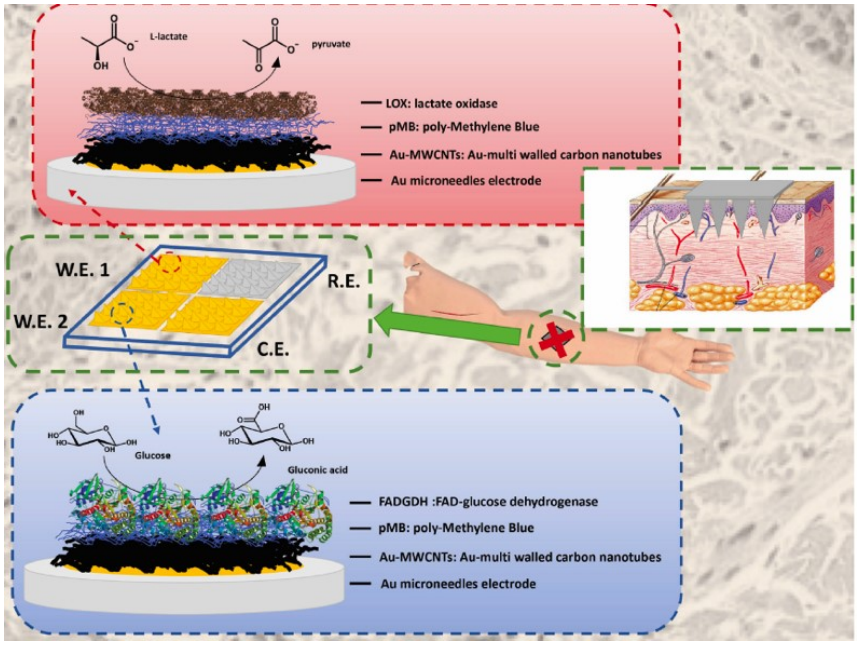

Figure 1. Schematic representation of microneedle-based biosensor array for simultaneous determination of glucose and lactate in ISF.

The gold surface of the microneedles has been modified by electrodeposition of Au-multiwalled carbon nanotubes (MWCNTs) and successively by electropolymerization of the redox mediator, methylene blue (MB). Functionalization of the Au-MWCNTs/polyMB

platform with the lactate oxidase (LOX) enzyme (working electrode 1) and with the FAD-Glucose dehydrogenase (FADGDH) enzyme (working electrode 2) enabled the continuous monitoring of lactate and glucose in the artificial ISF. The lactate biosensor exhibited a high sensitivity (797.4 ± 38.1 μA cm^{-2} mM^{-1}), a good linear range (10-100 μM) with a detection limit of 3 μM. The performances of the glucose biosensor were also good with a sensitivity of 405.2 ± 24.1 μA cm^{-2} mM^{-1}, a linear range between 0.05 and 5 mM and a detection limit of 7 μM. The biosensor array was tested to detect the amount of lactate generated after 100 minutes of cycling exercise (12 mM) and of glucose after a normal meal for a healthy patient (10 mM).

The results reveal that the new microneedles-based biosensor array holds interesting promise for the development of wearable real-time monitoring devices to be used in sport medicine and clinical care.

References

[1] Cass A.E.G. and Sharma S., Meth. Enzymol., 2017, 58, 413.

[2] Sharma S., Huang Z., Rogers M., Boutelle M. and Cass A.E.G., Anal. Bioanal. Chem., 2016, 408(29), 8427.

[3] Rawson T.M., Sharma S., Georgiou P., Holmes A., Cass A.E.G. and O'Hare D., Electrochem. Comm., 2017, 82, 1.

[4] Ventrelli L., Strambini L.M. and Barillaro G., Adv. Healthcare Mater., 2015, 4, 2606.