TiO_2 Nanotubes Alginate Hydrogel Scaffold for Rapid Sensing of Sweat Biomarkers - Lactate and Glucose

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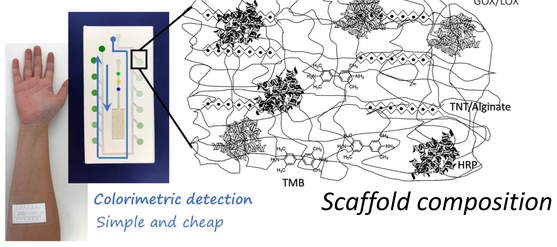
We propose a novel three-dimensional TiO_2 nanotubes/alginate hydrogel scaffold for the detection of sweat biomarkers, lactate and glucose, in artificial sweat. Hydrothermally synthesized TiO_2 nanotubes were introduced to the alginate polymer matrix and the hydrogel beads were formed by ionic crosslinking as the sensing scaffold. Rapid colorimetric detection was carried out for both, lactate and glucose, biomarkers in artificial sweat at 4 and 6 min, respectively. Moreover, the scaffold was integrated on a cellulose paper to demonstrate the adaptability of the material to other matrixes. The biocompatibility, the efficient immobilisation of biological enzymes/colorimetric assays and the quick optical signal readout behaviour of the TiO_2 nanotubes/alginate hydrogel scaffolds provide a prospective opportunity for integration into wearable devices.

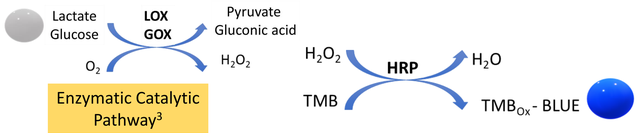
INTRODUCTION

Colorimetric detection of metabolites in sweat is simple, cheap and can be integrated to wearable devices. Nevertheless, long-time immobilization of enzymatic biological assays and rapid sensing are challenging in sweat sensors.[1,2]



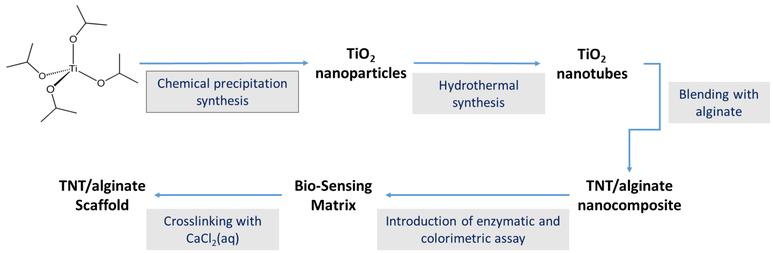
Scaffold composition

Superhydrophilic TiO_2 nanotubes (TNT) enhance the analyte transport ability of the sensor assay by promoting an effective capillarity through the alginate hydrogel.

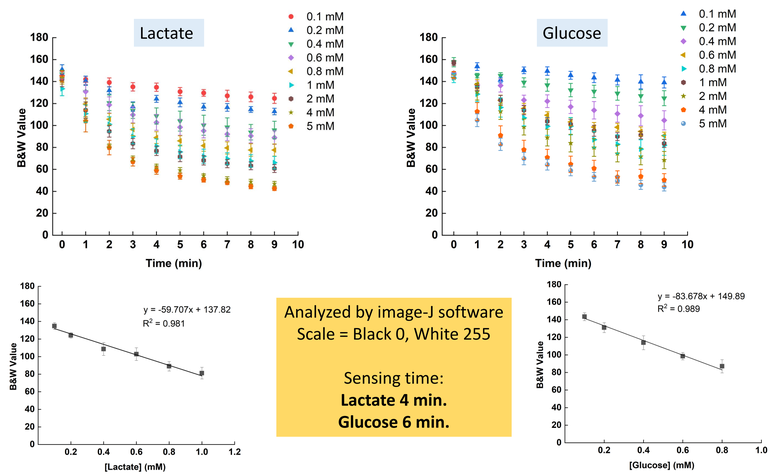


Enzymatic Catalytic Pathway[3]

FABRICATION OF THE SENSING SCAFFOLD



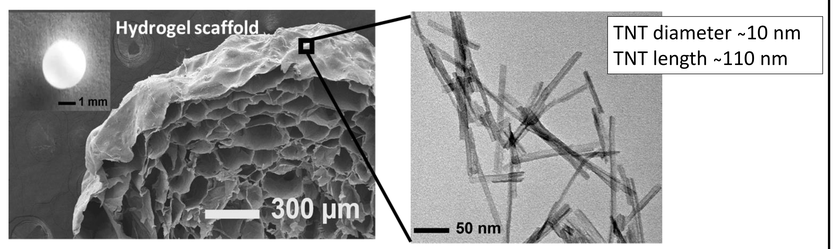
DETECTION OF SWEAT BIOMARKERS

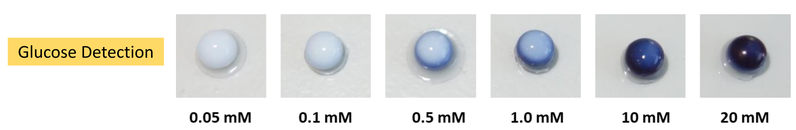


Analyzed by image-J software
Scale = Black 0, White 255

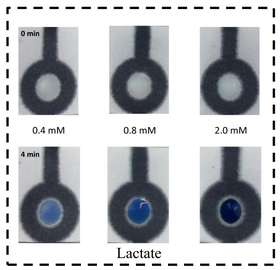
Sensing time:
Lactate 4 min.
Glucose 6 min.

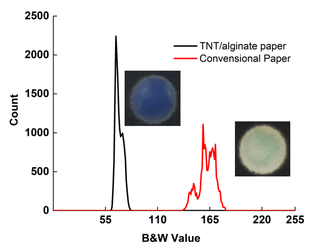
SCAFFOLD CHARACTERIZATION

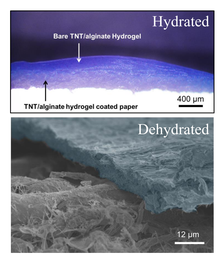




SCAFFOLD INTEGRATION







High assay loading capacity
Improved microfluidic paper-based sensor device performance

CONCLUSIONS

High biological assay loadings, quick signal responses and upstanding integration affinity of the introduced novel TNT/alginate sensing platform open new avenues to improve microfluidic analytical devices for real time detection of sweat biomarkers in wearable devices.

REFERENCES

1) U.B Gunatilake, *et al.* "TiO2 Nanotubes Alginate Hydrogel Scaffold for Rapid Sensing of Sweat Biomarkers: Lactate and Glucose." ***ACS Appl. Matter. & interfaces***, 13.31, 37734-37745, 2021.
2) J. Xiao *et al.*, "Microfluidic Chip-Based Wearable Colorimetric Sensor for Simple and Facile Detection of Sweat Glucose", ***Anal. Chem***, 91, 14803–14807, 2019.
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement H2020-MSCA-ITN-ETN-766007.