Towards an electronic smart patch for glucose and lactate monitoring

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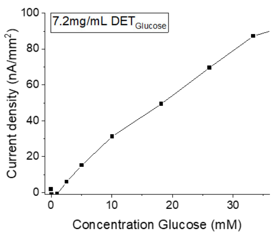
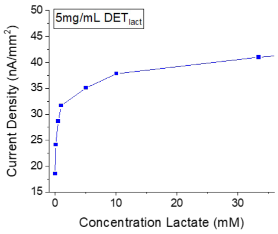
There is an increasing demand among professional and hobby athletes for wearable devices that allow the monitoring of fitness relevant biomarkers. The aim of the H2020-project ELSAH is to develop an electronic smart patch system for wireless monitoring of glucose and lactate in dermal interstitial fluid based on a biofunctionalized microneedle sensor. The metallized microneedles are modified by drop casting novel PEDOT:PSS polymer inks containing direct electron transfer (DET) enzymes and a topping hydrogel layer for mechanical protection and biocompatibility. We investigated the influence of different electrode materials (graphite, gold, platinum) on the enzyme kinetics. For all electrode materials similar values of the Michaelis-Menten constant (Km) were determined with ~25mM for $DET_{Glucose}$ and ~2mM for $DET_{Lactate}$. The PEDOT:PSS/DET inks were optimized with regard to polymer content and enzyme concentration. Higher current differences (for 80mM glucose, [$DET_{Glucose}$]: 7.2mg/mL) were measured on gold (200nA/mm^2) in comparison to platinum (90nA/mm^2). Platinum was chosen over gold for the microneedle metallization because of its better processability and lower environmental impact. With the optimized enzyme inks, glucose and lactate could be measured at an interference-free potential of 0V in the physiologically relevant range of 0.1-30mM. Current work focusses on dispensing the conductive enzyme inks with high throughput inkjet printing and other dispensing techniques.





Chronoamperometry results for glucose and lactate detection on Pt microneedles

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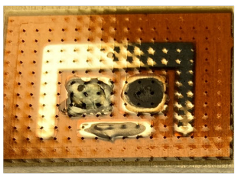
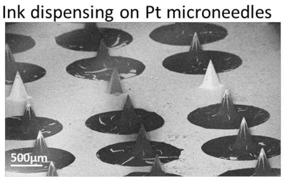


Drop casted microneedle sensor with DETGlucose and DETLactate modification

Outlook

Ink dispensing on Pt microneedles



SEM image of modified microneedles via BioDOT