Electrochemical glucose sensor based on glucose oxidase immobilized by chitosan matrix on laser-processed Au-Ti electrode

Wiktoria Lipińska[1], Katarzyna Siuzdak[1], Jakub Karczewski[2], Anna Dołęga[3], Katarzyna Grochowska[1]

[1] Centre for Plasma and Laser Engineering, The Szewalski Institute of Fluid-Flow Machinery, Polish Academy of Sciences, Fiszera 14 St., 80-231 Gdańsk, Poland
[2] Faculty of Applied Physics and Mathematics, Gdańsk University of Technology, Narutowicza 11/12 St., 80-233 Gdańsk, Poland
[3] Department of Inorganic Chemistry, Faculty of Chemistry, Gdańsk University of Technology, Narutowicza 11/12 St., 80-233 Gdańsk, Poland

wlipinska@imp.gda.pl

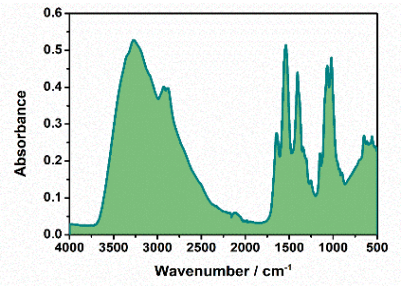
Nowadays diabetes comes out as one of the most common diseases. It is estimated that over 400 million people suffer from this illness. Therefore, scientists are bound to find a solution and create a glucose sensor, which will be sensitive, selective, stable as well as easy to produce.

Here, we propose the nanoscale Au-Ti heterostructure functionalized with glucose oxidase specific towards glucose presence. The fabrication of the electrode was realized by anodization of Ti foil and chemical etching resulted in the ordered Ti nanodimples (TiND). Next, gold nanoparticles (AuLr) were prepared by thin Au layer sputtering followed by laser dewetting [1]. Last but not least, the enzyme immobilization via entrapment into the chitosan matrix was performed.

The morphology of Ti nanodimples and Au nanoparticles was investigated by scanning electron microscopy and it is proven that nanoparticle size does not exceed the cavities dimensions. Fourier transformation infrared analysis was utilized to confirm the presence of glucose oxidase and chitosan. Experiments aimed at determining sensor parameters were conducted in 0.1 M PBS with glucose addition. The sensitivity factors of 23.67 and 10.05 $\mu A cm^{-2} mM^{-1}$ were determined and correspond to following linear ranges of 0.04 – 15.05 and 15.05 – 40.00 mM. The limit of detection equals only 1.77 µM. The selectivity of prepared electrode material was verified and no interference was observed. Moreover, validation in artificial/human sweat and saliva confirmed the potential application of the sensor for glucose monitoring in physiological fluids.

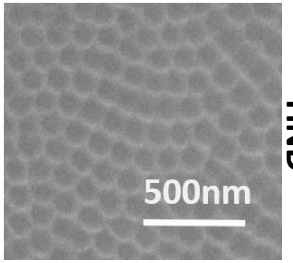
PREPARATION

MODIFICATION ANALYSIS

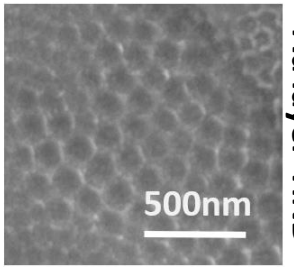


FT-IR spectrum for CHIT(GOx)/AuLr-TiND electrode

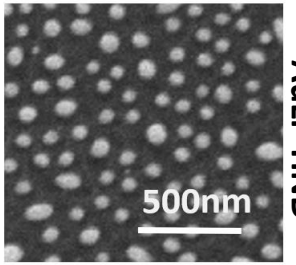
MORPHOLOGY



TiND

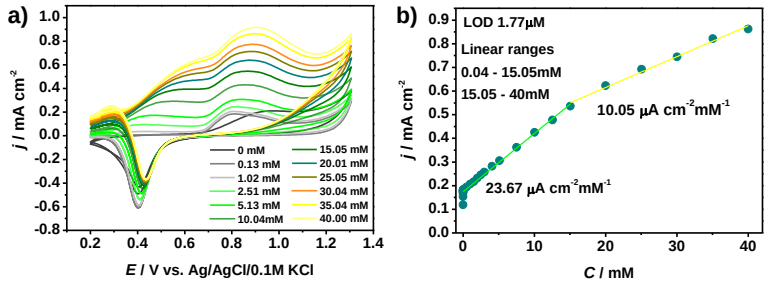


Au layer-TiND



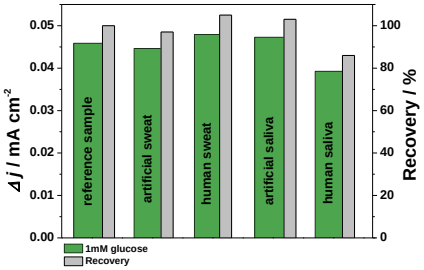
AuLr-TiND

ELECTROCHEMICAL ACTIVITY



a) Cyclic voltammetry curves registered for CHIT(GOx)/AuLr-TiND electrode with an addition of glucose in 0.1M PBS, b) calibration curve,

HUMAN BODY FLUIDS



Recovery test for artificial/human sweat and saliva for CHIT(GOx)/AuLr-TiND electrode

SUMMARY

- Proposed electrode is an excellent platform for glucose oxidase immobilization via entrapment method,
- Fabricated electrode is stable, selective and allows to detect glucose in human body fluids such as saliva and sweat. Due to that it can be used for glucose monitoring in non-invasive way.

[1] K. Grochowska, K. Siuzdak, J. Karczewski, G.Śliwiński, Appl. Surf. Sci. 357 (2015) 1684–1691. DOI:10.1016/j.apsusc.2015.10.053

This work has been financed by National Center for Research and Development under the LIDER program (LIDER/2/0003/L-8/16/NCBR/2017)