# MWCNTs Based Electrochemical Sensor for Direct Insulin Detection

**Petra Majzlikova**[1,2], Jan Prasek[1,2], Jana Chomoucka[1,2], Jana Drbohlavova[1,2], Radim Hrdy[1,2], Jan Pekarek[1,2] and Jaromir Hubalek[1,2]

[1] Department of Microelectronics, Brno University of Technology, Technicka 3058/10, Brno, Czech Republic
[2] Central European Institute of Technology, Brno University of Technology, Technicka 3058/10, Brno, Czech Republic
businova@feec.vutbr.cz

## Abstract

This work reports on the fabrication of planar multiwalled carbon nanotubes (MWCNTs) based working electrodes suitable for direct voltammetric detection of insulin. Insulin monitoring plays an important role in study of pathophysiology of various disorders especially diabetes. The commonly used assay methods for the determination of this hormone are lengthy, relatively imprecise and insensitive and they cannot be used by clinical laboratories. A direct electrochemical measurement of insulin is of considerable interest in the development of fast and sensitive amperometric detectors which can be coupled to flow systems or chromatographic instruments [1]. Several articles describing direct insulin detection using MWCNTs modified standard electrodes as a sensing element have been reported [2], but no work describing an electrochemical three-electrode MWCNTs based sensor especially made for direct insulin detection have been reported.

The aim of our work is to fabricate a disposable electrochemical sensor for direct insulin determination in aqueous solutions (shown in Fig. 1) employing cyclic voltammetry and chronoamperometry in a voltammetric cell against a conventional Ag/AgCl reference electrode and a platinum auxiliary electrode. Our first investigation in this field was focused on MWCNTs based working electrode fabrication and its optimization for insulin detection against common reference electrode and auxiliary electrode. An electrode substrate with contact (DuPont 7102 paste) for the WE was screen-printed on the alumina substrate with dimensions of 25.4 × 7.25 mm and ESL 243-s paste was used as an insulating layer. The standalone WE was spray-coated onto the electrode substrate using an airbrush (Fengda) (Fig. 2) and a mixture of MWNTs dispersed in N,N-dimethylformamide (DMF). SEM image of fabricated working electrode surface is shown in Fig. 3. Electrochemical detection was carried out in a three-electrode voltammetric cell using 0.05 M phosphate buffer solution (pH 7.4) as a supporting electrolyte against common Ag/AgCl reference electrode and platinum auxiliary electrode (both obtained from Metrohm, Switzerland). The cyclic voltammetry in the range of potential from 0 to +1 V using the scan rate of 50 mV/s and chronoamperometry at the potential +0.75 V were performed using PalmSens potentiostat (PalmSens, Nederland).

First results obtained using cyclic voltammetry in buffer solution contained 50 µmol/L of insulin at the MWNTs based planar WE (Fig. 4) confirmed our presumption that insulin could be detected on planar spray-coated microelectrodes similarly to modified conventional glassy carbon electrodes which is the first step to fabrication of screen-printed electrochemical sensor. The calibration curve of studied WE in the concentration range from 500 nmol/L to 2.5 µmol/L is shown in Fig. 5. As can be seen, the calibration curve is linear in the studied range of insulin concentrations with the correlation coefficient $R^2$=0.9706.

## References

[1] J Wang, et al., Analytica Chimica Acta, **581** (2007), p. 1–6.
[2] MG. Zhang, et al, Analytical Chemistry, **77** (2005), p. 6396–01.

## Acknowledgment

This work has been performed in laboratories supported by the operational program Research and Development for Innovation, by the SIX project CZ.1.05/2.1.00/03.0072 and by the project Research4Industry CZ.1.07/2.4.00/ 17.0006 from European Social Fund.

## Figures

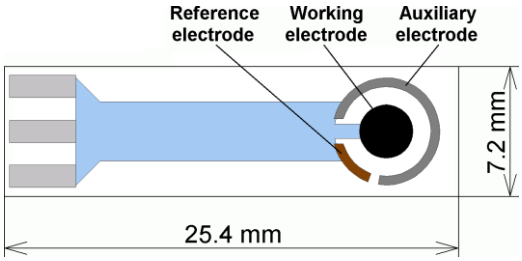


Figure 1. Designed screen-printed thick film sensor.

Figure 2. MWCNTs based spray-coated WE.

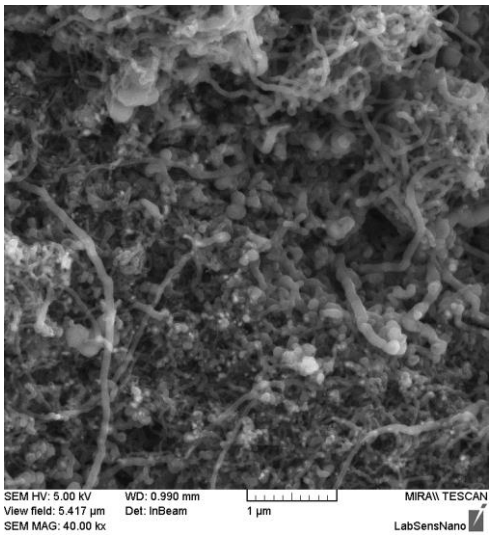


Figure 3. SEM image of MWCNTs based spray-coated working electrode at magnification of 40 kx.

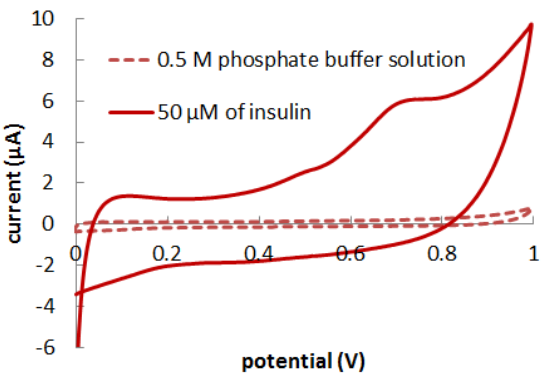


Figure 4. Cyclic voltammograms of MWNTs based working electrode of buffer solution (dashed line) and to 50 µmol/L of insulin (continuous line) using a scan rate of 50 mV/s.

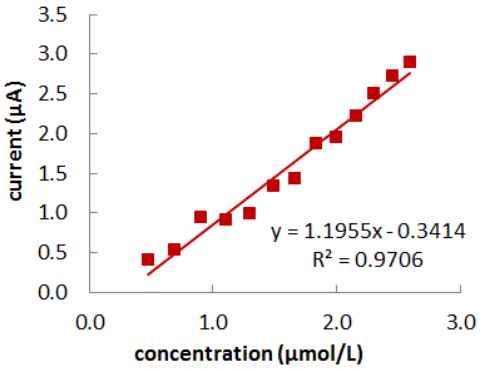


Figure 5. Calibration curve of planar spray coated MWNTs based working electrode obtained for the insulin concentrations from 500 nmol/L to 2.5 µmol/L.