Miniaturization of an Osmotic Pressure-based Glucose Sensor by Means of Nanosensing Technology

Andreas Pfützner[1-3], Sanja Ramljak[2], Konstantin Kloppstech[3], Alexander Kaya[3], Eugene Van Wyk[4], Nadja Hellmann[5], Rune Frisvold[1]; [1]Lifecase AS, Bergen, Norway; [2]Sciema UG, Mainz, Germany; [3]CantiMed UG, Darmstadt, Germany; [4]Cambridge Consulting, Cambridge, UK; Johannes-Gutenberg-University, Pharmacology and Biochemistry, Mainz, Germany

Background

The technology of the Sencell glucose sensor (Lifecare, Bergen, Norway) uses the competitive and reversible binding of glucose vs dextrane to the lectin concavalin A (ConA) to measure an osmotic pressure difference arising between a reagent chamber (containing ConA and dextrane) and a diffusion chamber, which is in direct contact with interstitial fluid to determine interstitial glucose concentrations. Both compartments are separated by a nanoporous membrane permeable to glucose and water, but not to ConA or dextran. Successful proof of concept studies have been performed in pigs with wired prototypes (2 x 1.5 x. 0.6 cm³). Substantial miniaturization of the measurement chamber and addition of wireless data and energy transfer are the next development steps.

Methods

To achieve miniaturization to the planned size of 2 x 3 x 6 mm³, cantilever-based very sensitive pressure transducers will be employed. These nano strain-sensors are composed of a carbon matrix in which nanogranular metals are being embedded and have a size of 20 x 50 nm². These nanosensors will be 3D-printed on the bottom of the pressure chamber or directly on the membrane. The employed ConA/dextrane system becomes more viscous upon up-concentration and will be replaced by a complex with similar fluidic properties even at high concentrations. Wireless power induction and data transfer requirements can be established by commercially available microelectronic components.

Results

The nano pressure sensors have been shown to be very robust and with stable signal performance (< 1 % drift over 6 months). The printing process can be used in highly reliable mass production procedures (CV between sensors < 0.01 %). A laboratory experimental working station will be developed to compare nanosensor performance with piezo resistive of-the-shelf sensors.

Fig.1.: Anticipated next miniaturization steps for the sencell device

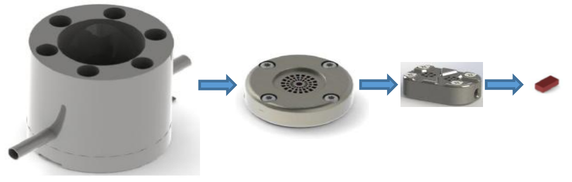


Fig.2.: Strain Nanosensor (orange arrow) 3D-printed on a cantilever that can be attached to the osmotic pressure chamber membrane

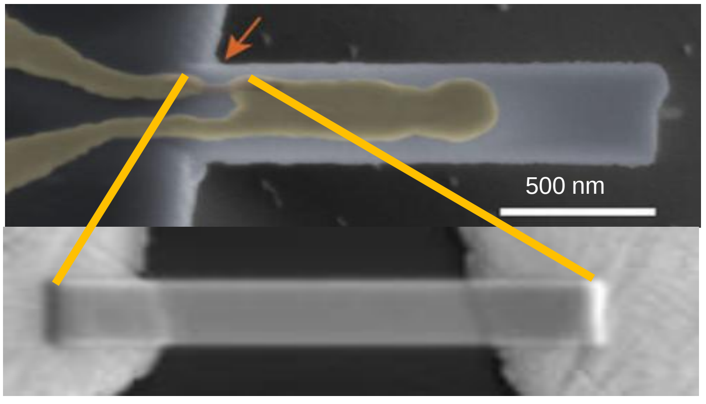


Fig.3.: Mode of action of the nanostrain pressure sensors

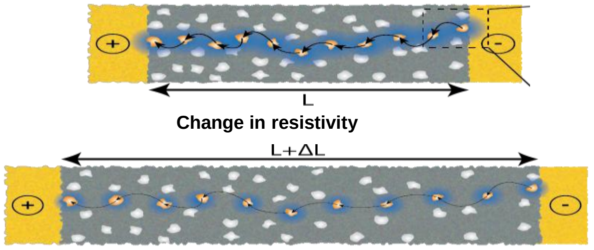
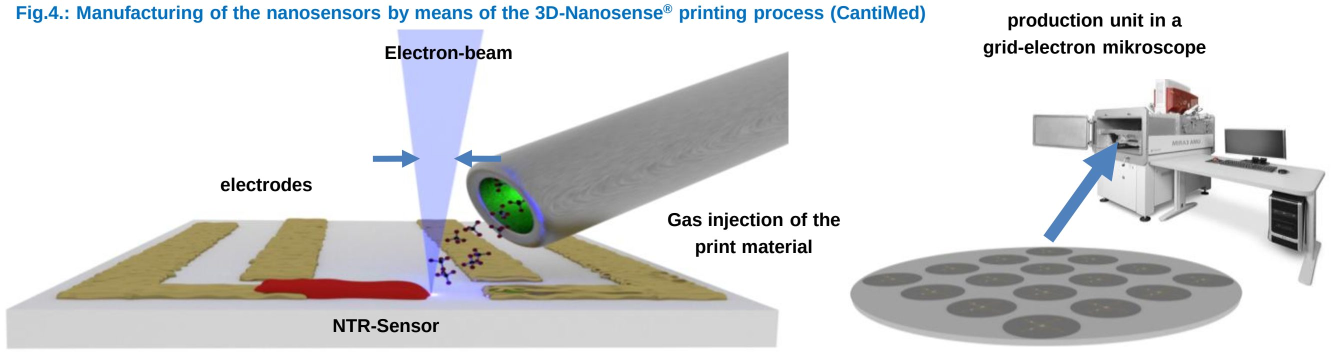


Fig.4.: Manufacturing of the nanosensors by means of the 3D-Nanosense® printing process (CantiMed)



Conclusions

When miniaturized to the desired small size by employing untrasensitive nano pressure sensors, the Sencell device is expected to provide higher convenience than needle sensors and a pronounced longevity (> 6 months).

LifeCare AS, Bergen, Norway: Contact Information: Rune Frisvold, CEO: +4790136063, Rune.frisvold@lifecare.no