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Licensing Opportunity

An Electrochemical Sensor formed from Sustainable Materials

Overview

Patients with diabetes typically use rapid point of care (POC) tests to measure blood sugar levels as an important aspect of managing their diabetes. This is conducted using 2-4 finger-prick tests/day using a test strip and blood testing meter. The glucose meter contains a sensor that enables glucose measurement. The electrochemical sensors for glucose measurement comprise an electrode and transducer. When glucose within a finger prick sample binds to the enzyme glucose oxidase (GOx) on the electrode the resultant reaction is converted to a measurable signal via the transducer.

First and second-generation sensors were developed in the 1970's and 80's and while they revolutionised diabetes management they suffered from poor anti-interference and stability issues.

New generation sensors (3rd generation) have overcome many of the obstacles of earlier generation sensors and have enabled more innovation in diabetes management, such as the continuous monitoring of blood glucose. Carbon nanotubes (CNTs) have become widely used as electrode materials due to their excellent conductivity and electrochemical inertness. The use of nanomaterials in the sensor can greatly improve the sensitivity of the sensor.

Technology

Carbon Fibre (CF) is acknowledged as an ideal material for enzyme immobilisation, however, present methods of producing CF are expensive and have an unsustainable environmental impact. The main source of carbon for materials such as carbon fibre for reinforced polymers is Polyacrylonitrile (PAN). The carbon footprint for PAN utilisation is estimated at 38.9kg CO2 per Kg produced.

This invention relates to a method to form a third-generation glucose biosensor utilising glucose oxidase (GOx) immobilised on mesoporous carbon nanostructures. These nanostructures were produced from a 50% alcell lignin and 50% polylactic acid (PLA) precursor blend.

Lignin is the second most abundant polymer in biomass, however, it is poorly valorised and is considered a low-value by-product of the pulp industry. The UL research team have over seven years expertise in utilising lignin to produce Carbon fibre and Carbon Nanotubes for use in high-value products.

This particular technology uses two biobased polymers that are blended with lignin prior to carbonisation. Once carbonised very different carbon morphologies are produced, and the differences in these morphologies produce optimised biosensors for glucose detection.

The ability to utilise lignin as an alternative, low cost and sustainable source of carbon offers a new horizon for lignin in biomedicine.

Benefits

This technology allows the production of sensors suitable for use in biomedical applications that:
Have a low cost of production.
Can utilise fully biobased raw materials, including a variety of sustainable feedstocks.
Have a fast carbon nanofibre precursor stabilisation process.
The carbon nanofibre porous microstructure is ideal for sensing applications and offers:
Excellent enzyme immobilisation capability.
High sensitivity for glucose allows for non-invasive glucose testing.
High selectivity for glucose (low Michaelis-Menten constant).
Long shelf life.
The enzyme has a fast electron transfer with the electrode as well as a high coverage when compared to other carbon-based electrodes. Structure/property relationships can be tailored for other sensing applications.

Applications

- ✓ Hospital, point of care testing for diabetes.
- ✓ Enzyme immobilising sensor with applications in blood glucose monitoring. Due to the high sensitivity for glucose detection this technology could be used in minimally invasive monitoring using samples such as interstitial fluid, sweat and saliva.
- ✓ This electrochemical detection technology has also been used to successfully detect Dopamine and has the ability to detect a range of other biomolecules.

Commercial Opportunity

The University of Limerick is seeking partners to exploit the commercial potential of these technologies by entering into licensing agreements.

☐ Development partner

☒ Commercial partner

☒ Licensing

☒ University spin-out

☐ Seeking investment

Patent reference:

PCT/EP2022/063815 - Improvements Relating to Electrochemical Sensors

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Figures

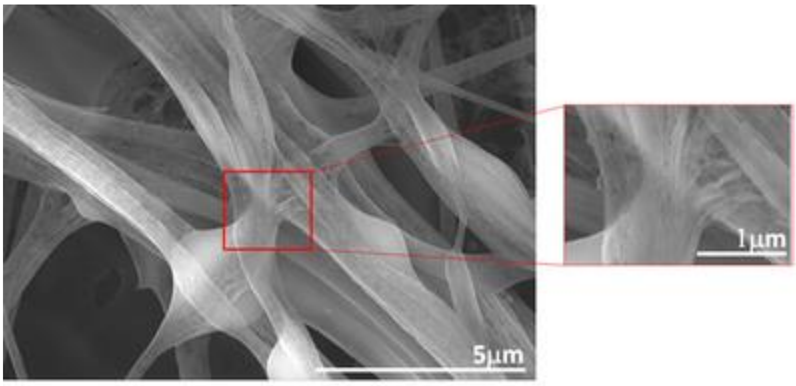

Figure 1: SEM images of the nanofibres.

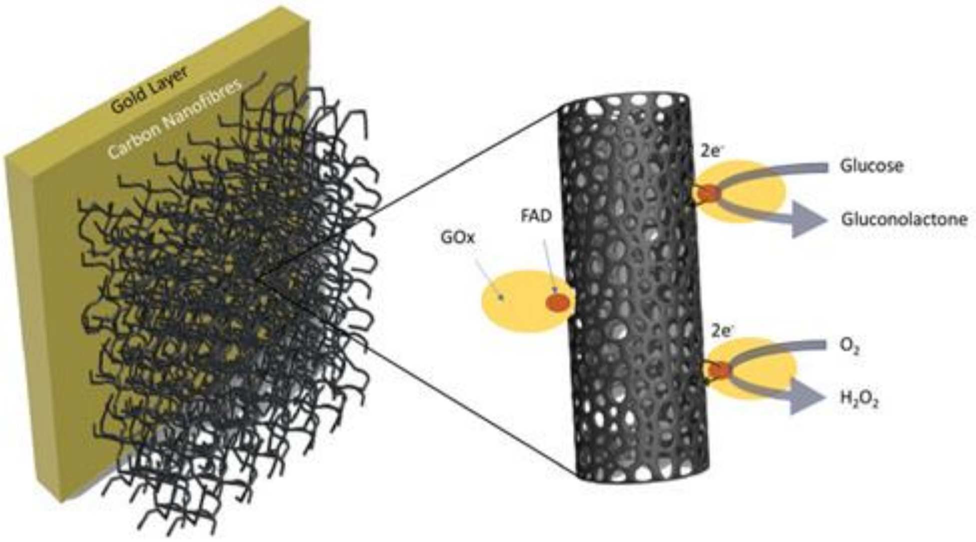

Figure 2. Schematic of the DET competitive processes between GOx and the surface of the electrode.