Enzymatic doped ionogels - new materials for inherently biocompatible molecular sensors

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Introduction:

- The key challenges currently faced in lab-on-a-chip biochemical sensor developments are device reliability and power consumption.
- Point-of-care (POC) glucose biosensors play an important role in the management of blood sugar levels in patients with diabetes. Glucose biosensors still account for approximately 85% of the current world market which is estimated to be worth $5 billon.[1]
- Ionic liquids (ILs) have evolved as a new type of solvent for biocatalysis, mainly due to their unique and tunable physical properties.[2]

Project Aims:

- **Enzymatic doped Ionic Liquids - new materials for inherently biocompatible molecular sensors.**
- **Develop a flexible, wearable biocompatible molecular sensor.**

Ionic liquids: An introduction

- Ionic liquids (ILs) are low melting salts, thus forming liquids that are comprised entirely of cations and anions.
- According to current convention, a salt melting below the normal boiling point of water (> 100 °C) is known as an "ionic liquid".
- The number of potential anion-cation combinations available reputedly equate to one trillion (10^{12}) different Ils.
- Vast range of applications such as in green chemistry, electrochemistry & biotechnology (Fig 1).

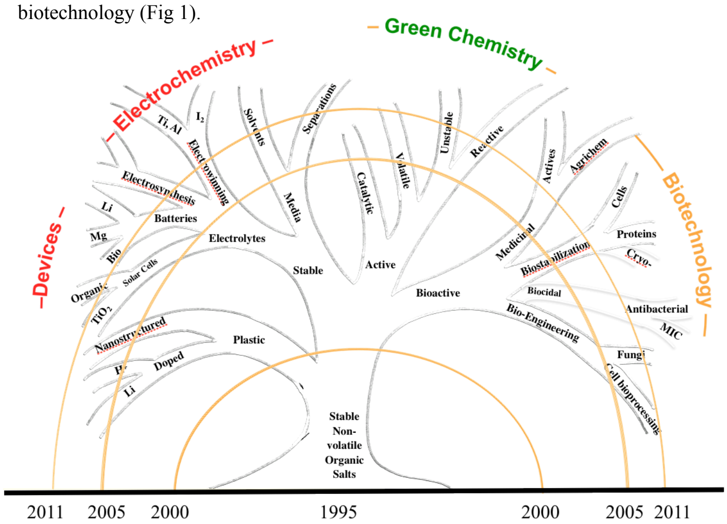

Fig 1: Ideas tree of Ionic Liquids.[3]

Fabric sensor: Carbon Cloth

- 500 µm threads consisting of a bundle of 10 µm fibers (Fig 2).
- Allows for flexible substrates.
- Single threads were soaked in a IL / Ferrocene / GOx enzyme solution.

Fig 2: Carbon cloth as a substrate for biocompatible sensing.

- Ionic liquids used in this study include [C_2mIm][$EtSO_4$], [$P_{6,6,6,14}$][Cl], [$P_{6,6,6,14}$][dca] and [$P_{6,6,6,14}$][NTf_2] (Fig 3).

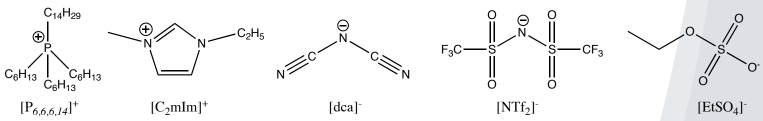

Fig 3: Cations / anions used in this study.

Results & Discussion:

Electrochemical sensing:

- SEM image (Fig 4) shows excellent coverage of the threads resulting in a large working surface area. Using the Anson equation, the calculated working area was approx 0.138 cm^2.
- Due to the hydrophobic nature of the cloth, [$P_{6,6,6,14}$][dca] was chosen as the electrolyte.
- Significant response shown at 7.5 mM glucose addition (Fig 5).

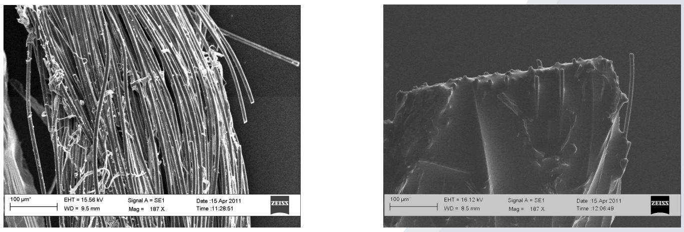

Fig 4: SEM images of carbon cloth & carbon cloth soaked in [$P_{6,6,6,14}$][dca] / Ferrocene / Gox.

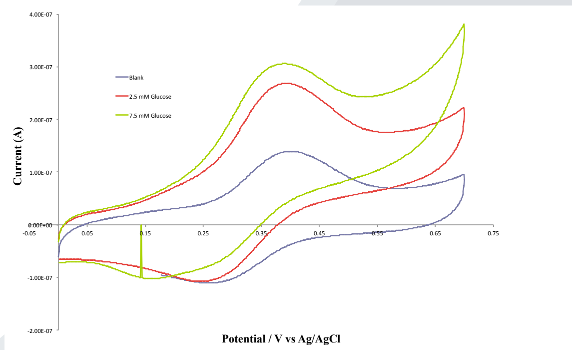

Fig 5: CV of Glucose additions to [$P_{6,6,6,14}$][dca]/Ferrocene/Gox on carbon cloth. Scan rate 0.01 V/S.

Conclusions:

- Carbon cloth shows potential as a flexible working electrode.
- Can be woven into sports athletes clothing.
- Durable, flexible sensing platform.
- [$P_{6,6,6,14}$][dca] as an electrolyte in the glucose system shows low limit of detection.

References

[1] Newman, J.D., Warner, P.J., Turner, A.P.F. & Tigwell, L.J. (2004). Biosensors: A Clearer View. Cranfield University, UK, 216pp.
[2]Zhao, H. (2010), Methods for stabilizing and activating enzymes in ionic liquids—a review. Journal of Chemical Technology & Biotechnology, 85: 891–907. doi: 10.1002/jctb.2375
[3] http://www.chem.monash.edu.au/ionicliquids/

Funding Acknowledgement
This work is supported by a Marie Curie Actions International Re-integration Grant (IRG) (PIRG07-GA-2010-268365) and Irish Research Council for Science, Engineering and Technology .

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