Organic Electrochemical Transistor Incorporating an Ionogel as Solid State electrolyte for Lactate Sensing

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Outline

- Introduction
  - ✓ Wearable Sensors
  - ✓ Lactate and Sweat
- Diverse materials for sensing using OECTs
  - ✓ Ionic Liquids
  - ✓ Ionogel
- Results
- Conclusions

Physiological & Chemical Sensors

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LIFESHIRT®

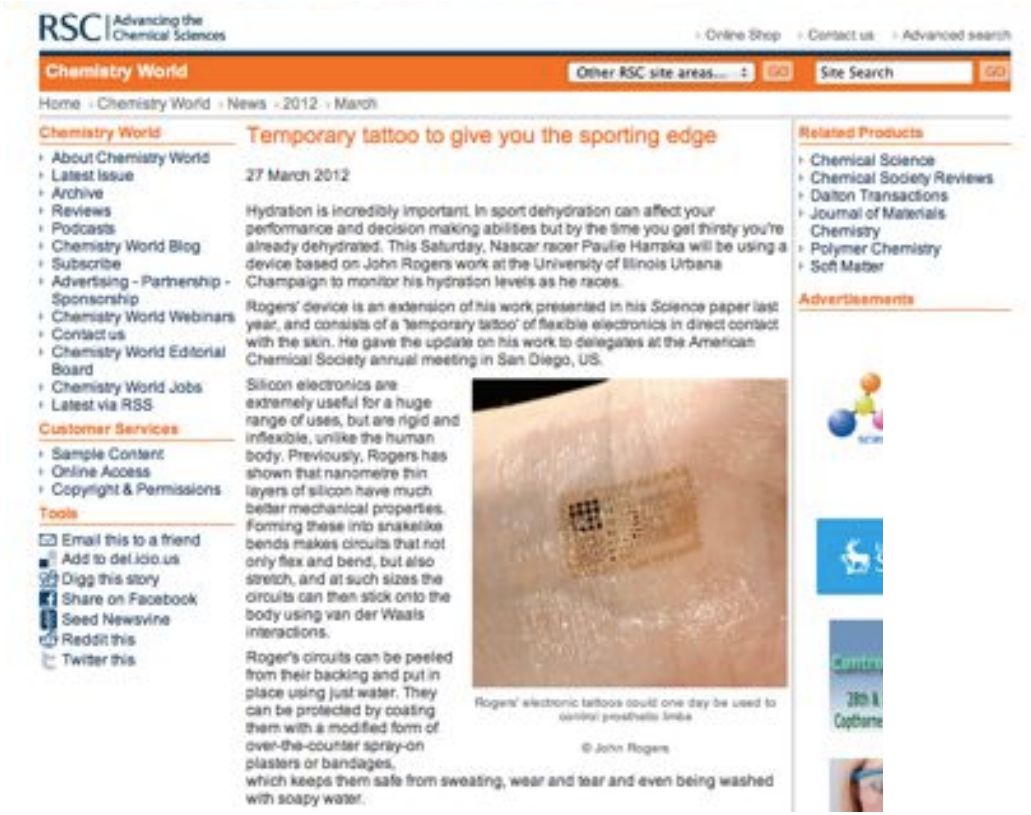
- ✓ Breath rate,
- ✓ Heart rate,
- ✓ Posture
- ✓ Skin temperature
- ✓ …

Medtronic Diabetes' Guardian®

NIKE-APPLE iPOD Sports Kit®

Lactate Scout®

Wearable Sensors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Temporary tattoo to give you the sporting edge

27 March 2012

Hydration is incredibly important. In sport dehydration can affect your performance and decision making abilities but by the time you get thirsty you're already dehydrated. This Saturday, Nascar racer Paulie Harraka will be using a device based on John Rogers work at the University of Illinois Urbana Champaign to monitor his hydration levels as he races.

Rogers' device is an extension of his work presented in his Science paper last year, and consists of a 'temporary tattoo' of flexible electronics in direct contact with the skin. He gave the update on his work to delegates at the American Chemical Society annual meeting in San Diego, US.

Silicon electronics are extremely useful for a huge range of uses, but are rigid and inflexible, unlike the human body. Previously, Rogers has shown that nanometre thin layers of silicon have much better mechanical properties. Forming these into snakelike bends makes circuits that not only flex and bend, but also stretch, and at such sizes the circuits can then stick onto the body using van der Waals interactions.

Roger's circuits can be peeled from their backing and put in place using just water. They can be protected by coating them with a modified form of over-the-counter spray-on plasters or bandages, which keeps them safe from sweating, wear and tear and even being washed with soapy water.

Rogers' electronic tattoos could one day be used to control prosthetic limbs

© John Rogers

Link :http://www.nsf.gov/news/news_su

Rogers @ University of Illinois

11/08/2011

-thin, self-adhesive electronics


You are here: Home > Health > Health News

The 'electronic skin' patches that can tell when you're ill

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Tuesday March 27 2012

Electronic skin patches that monitor a patient's health while at home are being developed by scientists.

American researchers say the tiny patches, with tattoo-like sensors that wirelessly diagnose and treat health problems, can act as a person's own internal doctor.

The "electronic skin" patches, about as a thick as a human hair, check a patient's "vital signs" and transmits the data to a computer or mobile phone.

Scientists behind the project also say they could be used by healthy people to detect the early signs of illness.

The first patches, aimed at athletes, are expected to be available for commercial sale later this year.

The information then gets sent to the person's doctor for further analysis, who can then act on any worrying conclusions.

They are made of a silicon membrane that stretches and moves with the body.

Sensors contained within the patches can measure heart rates and temperatures and monitor whether injured muscles are healing.

The first patches, aimed at athletes, are expected to be available for commercial sale later this year. Photo: Getty Images

Also in Health News

- It's official! Chocolate can help keep you slim
- Heart attack risk increases for 48 hours after clocks fall forward
- Redheads feel more pain than people with dark hair
- Killer bug: New drug could halt spread of C diff in hospitals
- More homes are now smoke-free thanks to

I HAVE TO MKE THIS SLIDE – It is going to be sweat&lactate

Sweat is naturally generated during exercise.

Monitoring its contents provides very rich information about the physiological condition of the individual.

Rehydration and re-mineralisation

↓

Improve performance and general health

Sweat analysis: identify pathological disorders

- ✧ Cystic fibrosis*
- ✧ Information on dehydration
- ✧ Changes in the concentration of biomolecules and ions
- ✧ Hyponatremia (low sodium concentration)

*Common hereditary disease which affects the entire body, causing progressive disability and often early death.

OECTs and Wearable sensors

Advantages

- ✓ simple electrical readout
- ✓ inherent signal amplification
- ✓ facile incorporation into arrays and circuits.
- ✓ printing technologies make their fabrication particularly cost-effective for future industrialization.

Disadvantages

Electrolyte to put in contact gate and channel

- ✓ complex liquid handling architecture
- ✓ leakage and contamination
- ✓ degradation of bio macromolecule in solution (PBS)

Ionic Liquids: A brief introduction

Ionic liquids (ILs) have evolved as a new type of non-aqueous solvents for biocatalysis, mainly due to their unique and tunable physical properties[1]

A liquid that is composed entirely of ions (M_p < 100 °C)

Factors that affect Enzyme activity in ILs

IL polarity

Hydrogen bonding

Viscosity

Ion kosmotropicity

Enzyme dissolution

H. Zhao, *J. Chem. Tech. Biotech*, 2010, **85**, 891-907.

Ionic Liquids: A brief introduction

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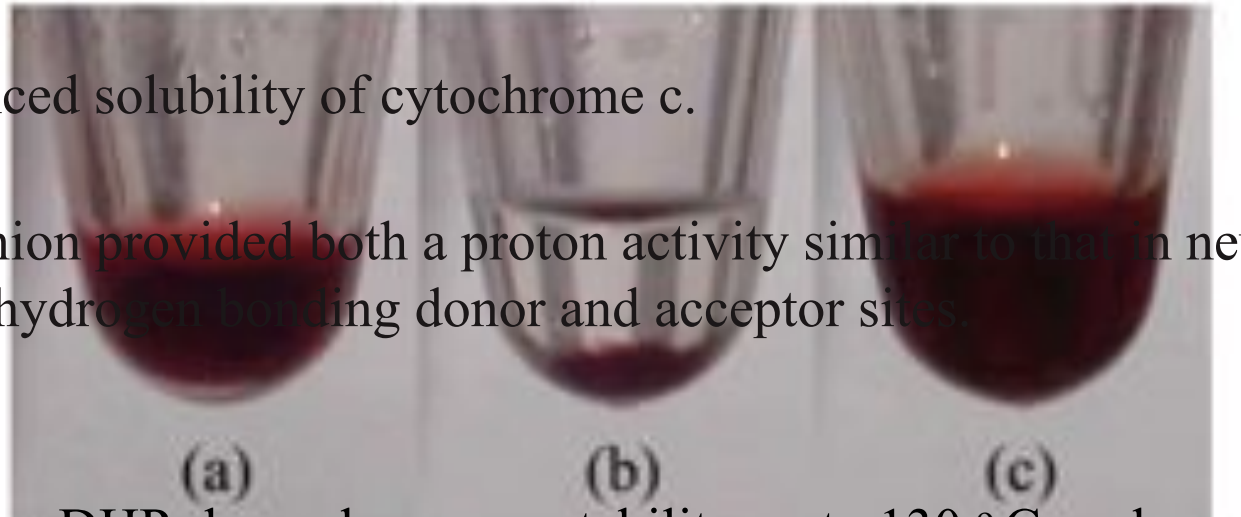
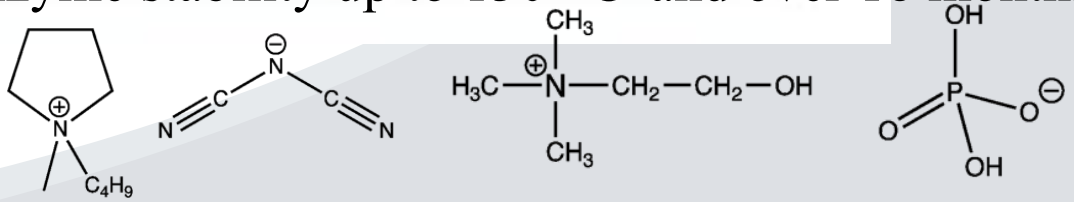
Through smart design enzyme stability can be greatly enhanced



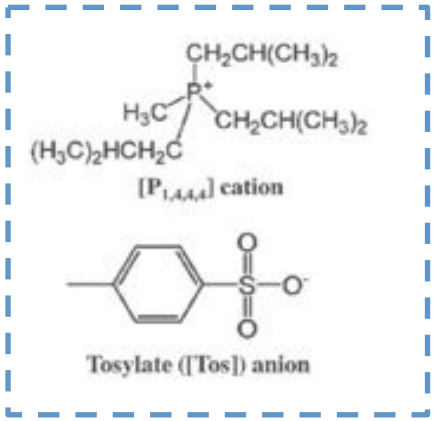
- Enhanced solubility of cytochrome c.
- dhp anion provided both a proton activity similar to that in neutral water as well as hydrogen bonding donor and acceptor sites.
- Choline DHP showed enzyme stability up to 130 °C and over 18 months at RT [2]

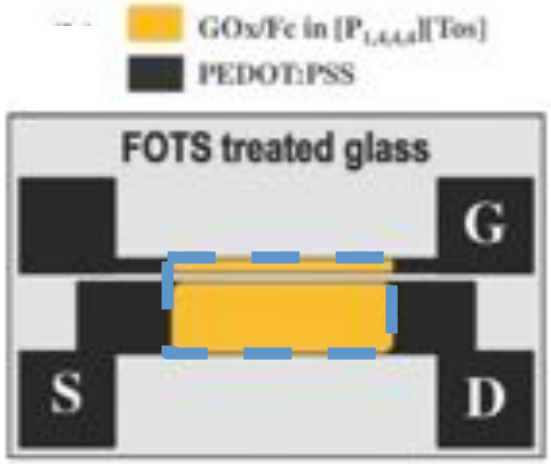
PBS

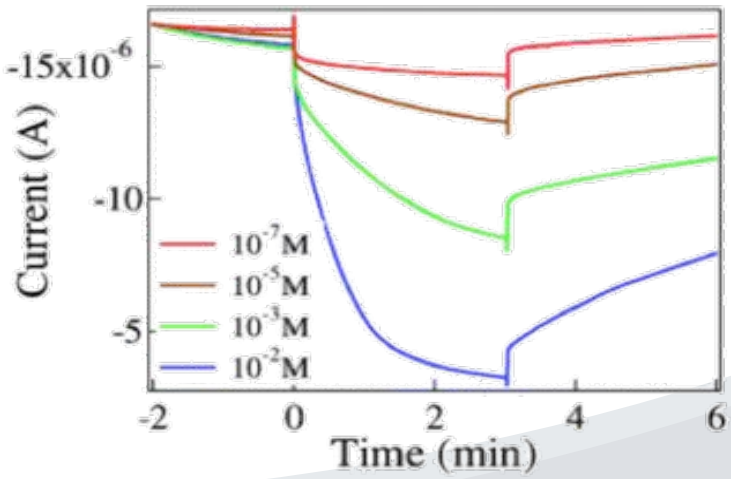


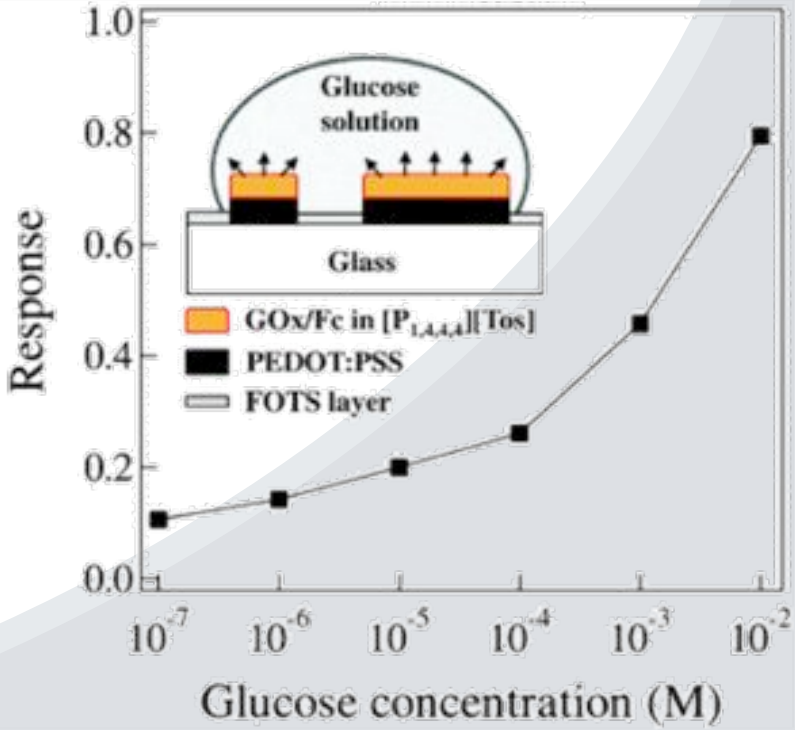
K. Fujita, D. R. MacFarlane and M. Forsyth, *Chem. Commun.*, 2005, 4804-4806.

Ionic liquids & OECTs: Glucose Sensor



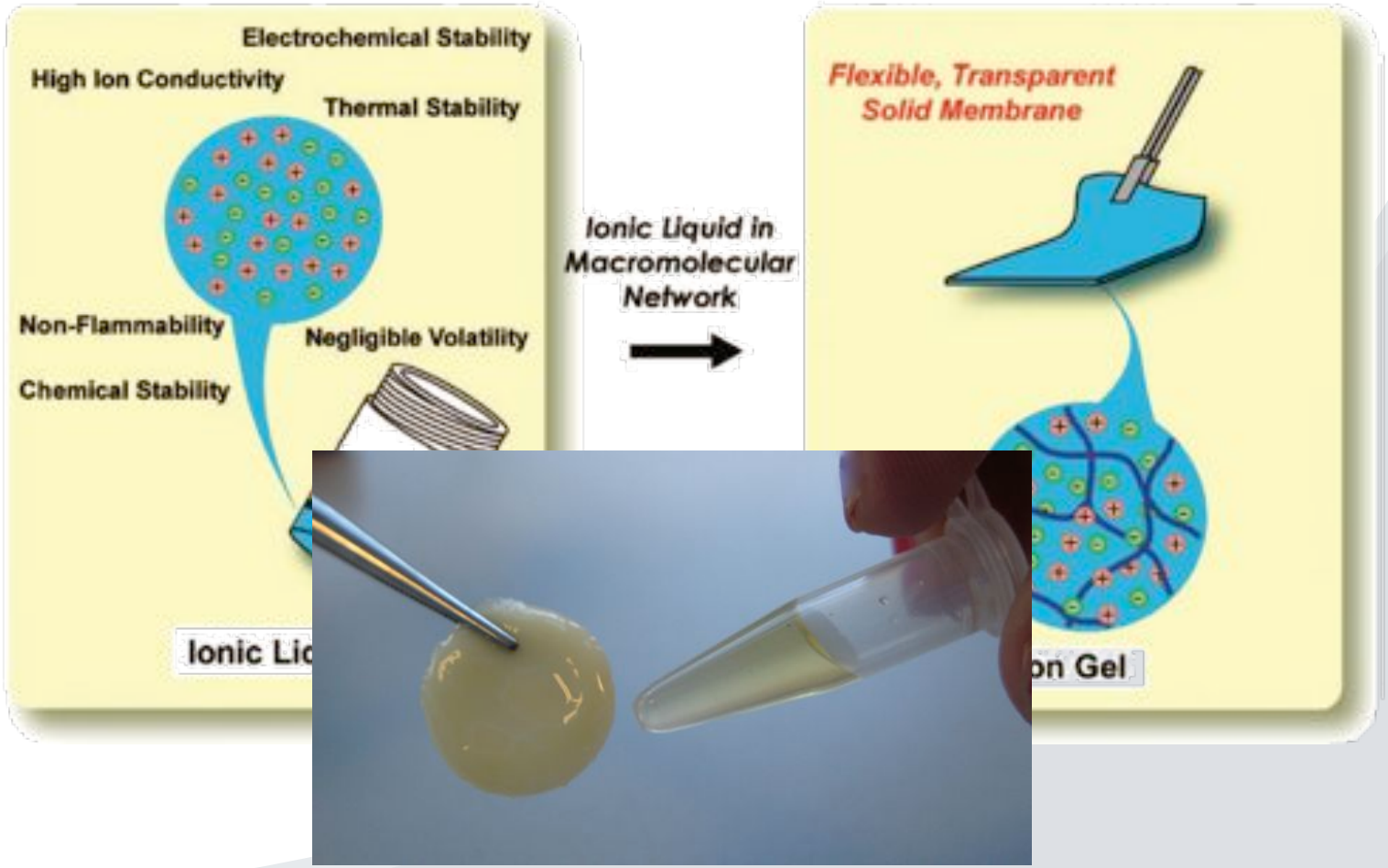






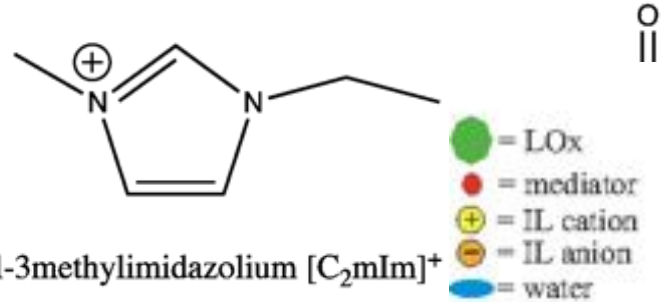
S. Y. Yang, F. Cicoira, R. Byrne, F. Benito-Lopez, D. Diamond, R. A. Owens and G. G. Malliaras, *Chem. Commun.*, 2010, **46**, 7972-7974.

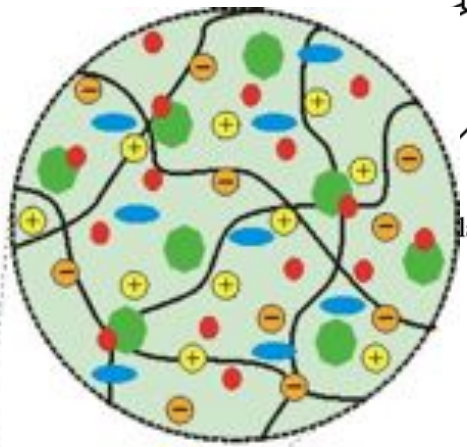
Ionogel – ILs in macromolecules

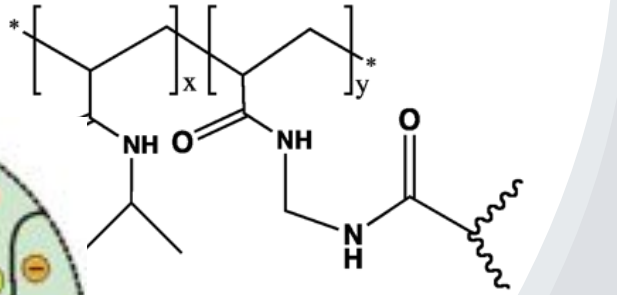


4. T. Ueki and M. Watanabe, *Macromolecules*, 2008, **41**, 3739-3749.

Ionogel & OECTs: Lactate Sensor

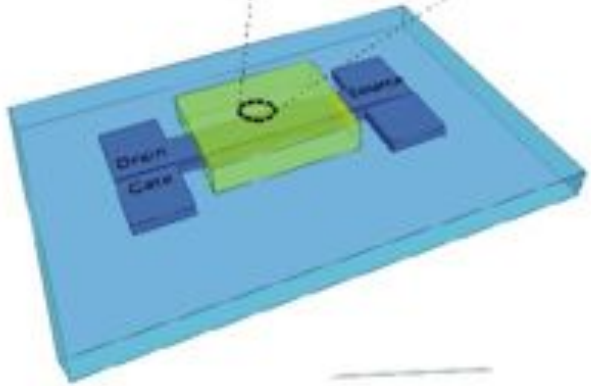




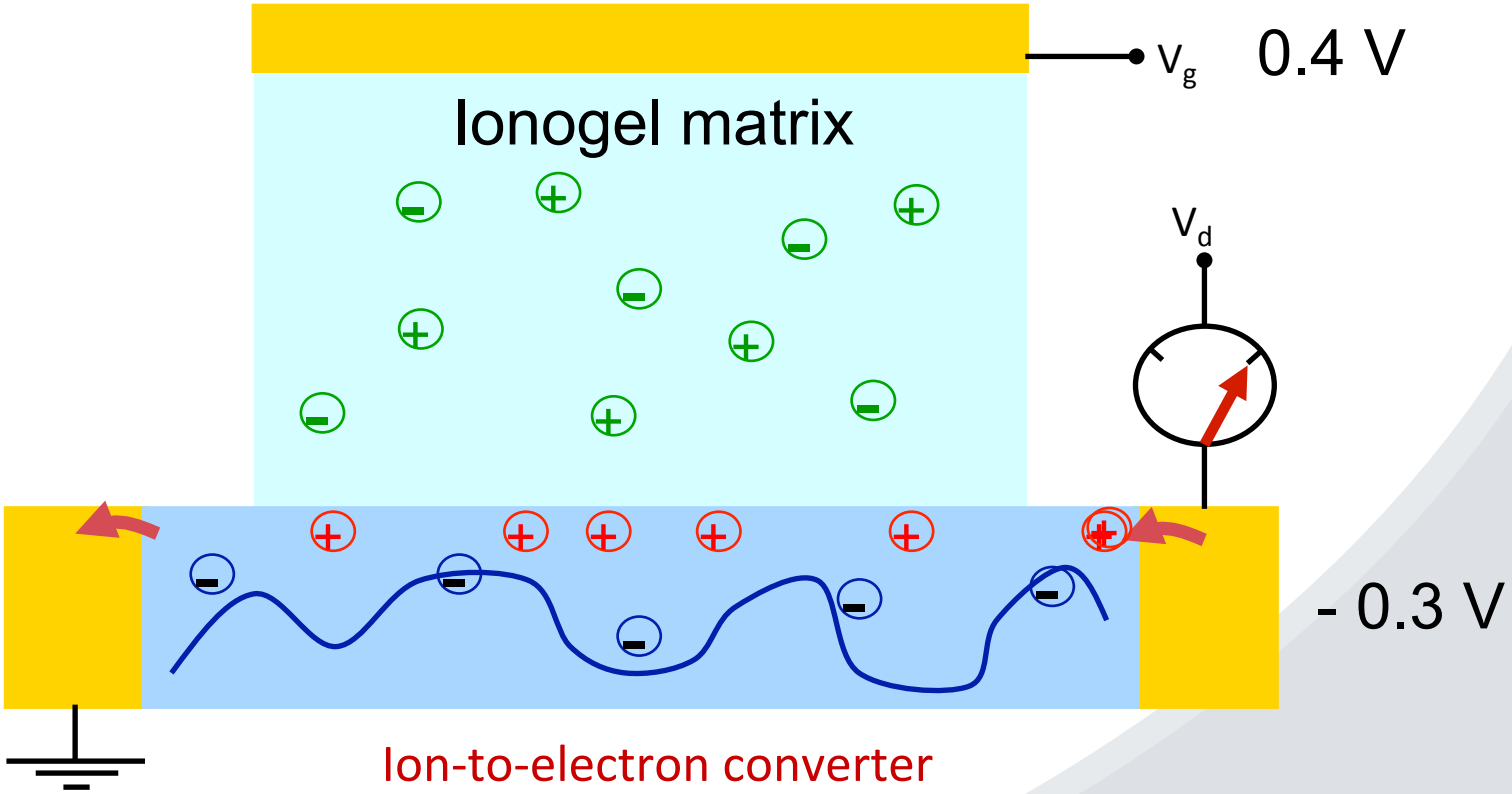


lacrylamide-co-*N*,*N*'-methylenebisacrylamide)

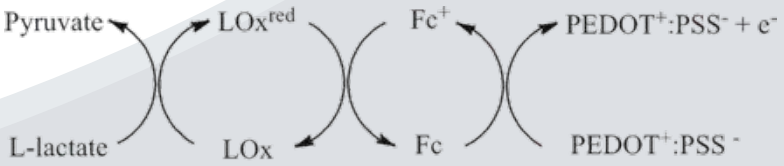
- Hydrophilic IL - avoi nalyte solution.
- Hydrated IL complete ipitation observed
- 20 uL final solution d
- UV polymerised for 1



Ionogel & OECTs: Lactate Sensor

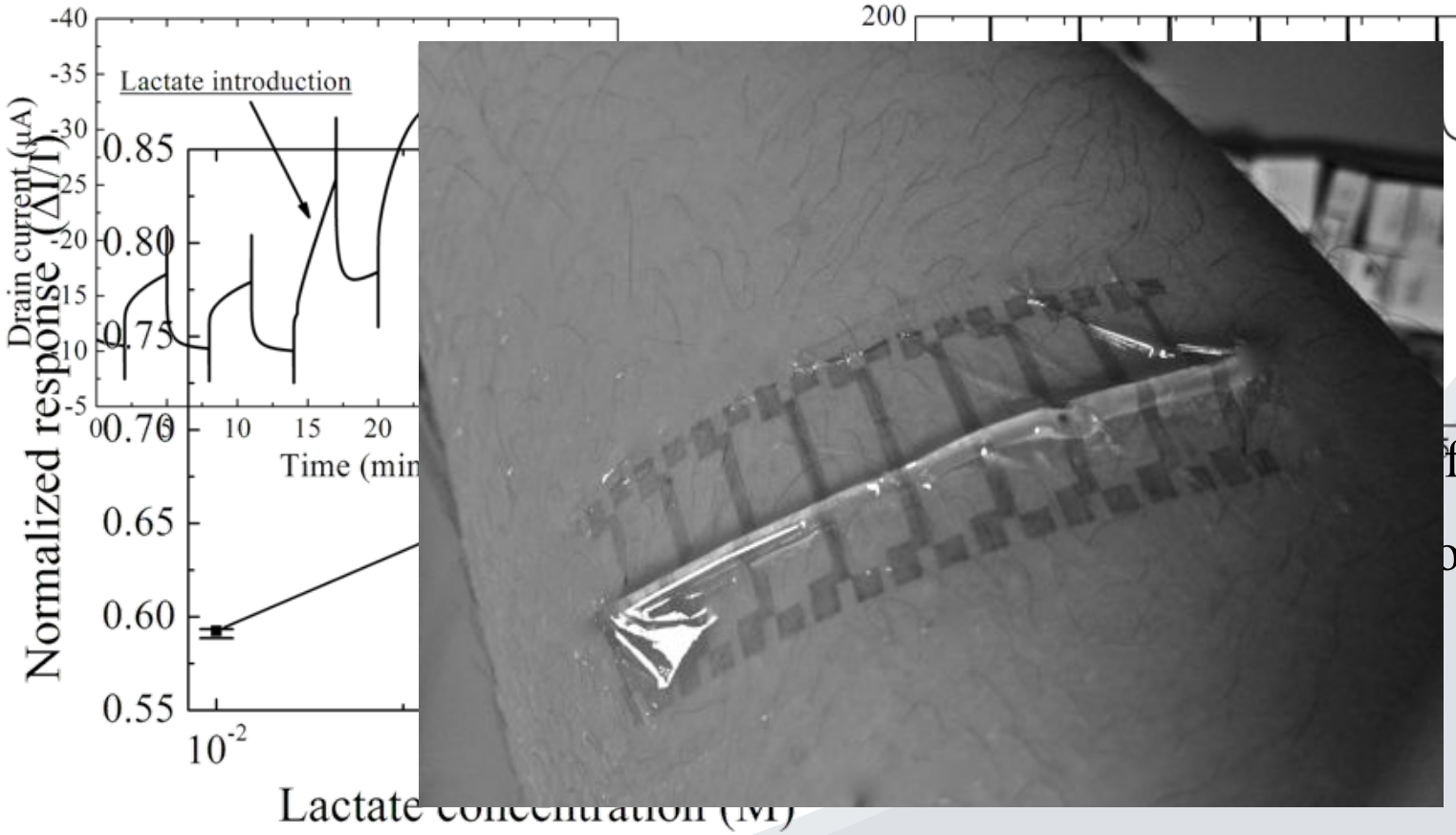


Introduction 20 uL of PBS solution with desired lactate concentration



$$PEDOT^+:PSS^- + M^+ + e^- \longrightarrow PEDOT + M^+:PSS^-$$

Ionogel & OECTs: Lactate Sensor



100 mM

f sweat

on of lactate

D. Khodagholy, V. F. Curto, K. J. Fraser, M. Gurfinkel, R. Byrne, D. Diamond, G. G. Malliaras, F. Benito-Lopez and R. M. Owens, J. Mater. Chem., 22, 4440 (2012).

Conclusions

- Detection of lactate in a relevant physiological range (10 - 100 mM) using a solid state electrolyte-OECTs Biosensor
- Novelty lies in the configuration of the sensor
- Solid State electrolyte overcomes problems related the design of a future wearable sensor

FUTURE WORK:

- Enzyme stability and reliability of the system under investigation
- Incorporate OECT / Ionogel into a wireless communicated microfluidic device.

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Thank you for your attention