

Novel Electronic Smart Devices for Healthcare Applications

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Wireless Implantable Medical Devices



Cardiac Resynchronisation Therapy Defibrillator Device



<http://www.dailymail.co.uk/health/article-2403811/Triathlete-Andrew-Britton-dies-6-times-honeymoon-catching-heart-attacking-virus.html>

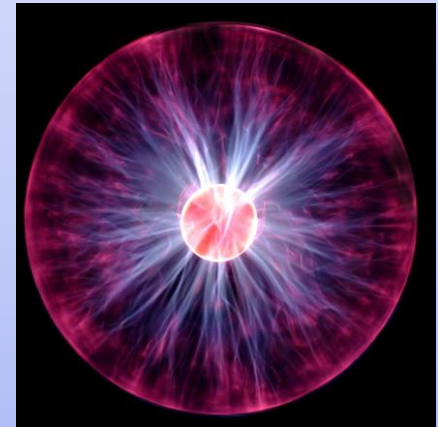
Medical Device Associated Infections – Urinary Catheters

- **Uncoated latex, PVC, plastic, silicone catheters**
 - Higher risk of infection
 - Oral antibiotics
 - Side effects
- **Antimicrobial/antibiotics/antiseptic coated catheters**
 - Expensive silver alloys and silver oxide materials
 - Spontaneous drug discharge/diffusion
 - Higher manufacturing costs

Using Nature's Green Source - Electrons

➤ Antibiotic loaded electroactive catheter

- Controlled delivery
- Reduced side effects
- Regulated dosage
- Minimal invasive
- Minimum drug consumption
- Low manufacturing cost



Conducting Polymers as Drug Delivery Media

Advantages

Conductive material with flexibility of a polymer!

Drug incorporation: electrochemical doping

Drug release: electrochemical de-doping

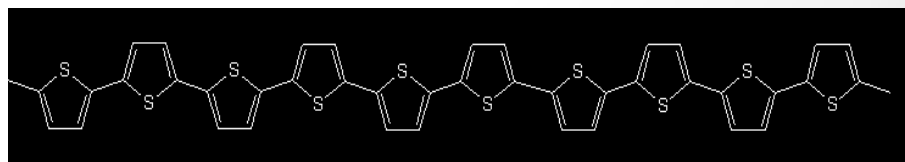
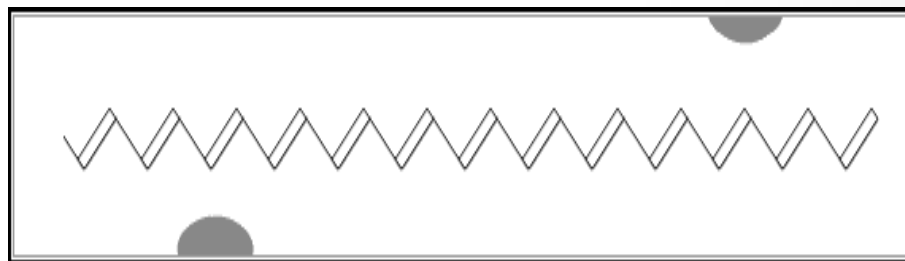
Synthesis

Chemical

Electrochemical

One-step process

Polymer synthesis & drug loading



H. Shirakawa, E. J. Louis, A. G. MacDiarmid, C. K. Chiang and A. J. Heeger, *J. Chem. Soc., Chem. Commun.*, 1977, 578-580

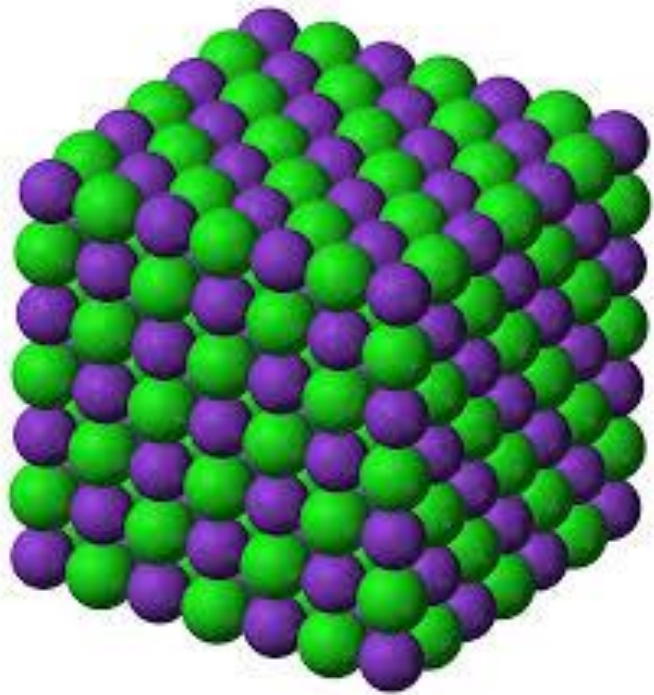
Challenges

- **Conducting Polymers**
 - Intractable
 - Not thermoformable
 - Insoluble
- **Conducting Polymer Composites**
 - Biocompatibility and aqueous stability
 - Spontaneous drug discharge/diffusion by hydrogel
 - Higher manufacturing costs
- **Drug Loading into Conducting Polymer Matrix**
 - Solubility of hydrophobic drugs
 - Need for novel solvents

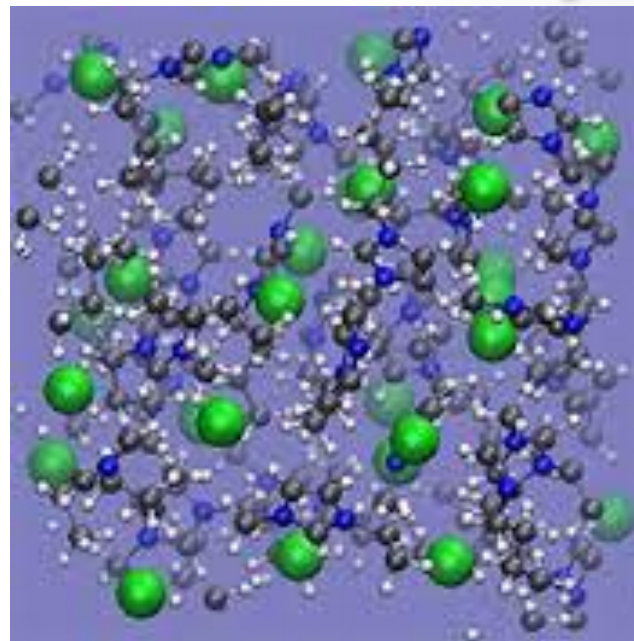
Ionic Liquids as Neoteric Solvents for Biomedical Applications

...

Disorderliness is not always bad



Sodium
Chloride



Ionic
liquids





Ionic liquids don't smell

Ionic liquids don't catch fire

Ionic liquid



Organic solvent



Designer solvent

Ionic Liquids in Pharma



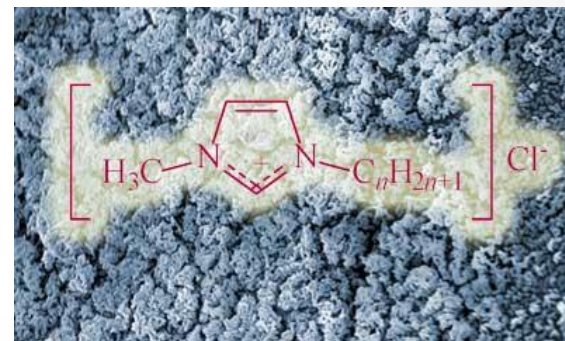
1200 °C



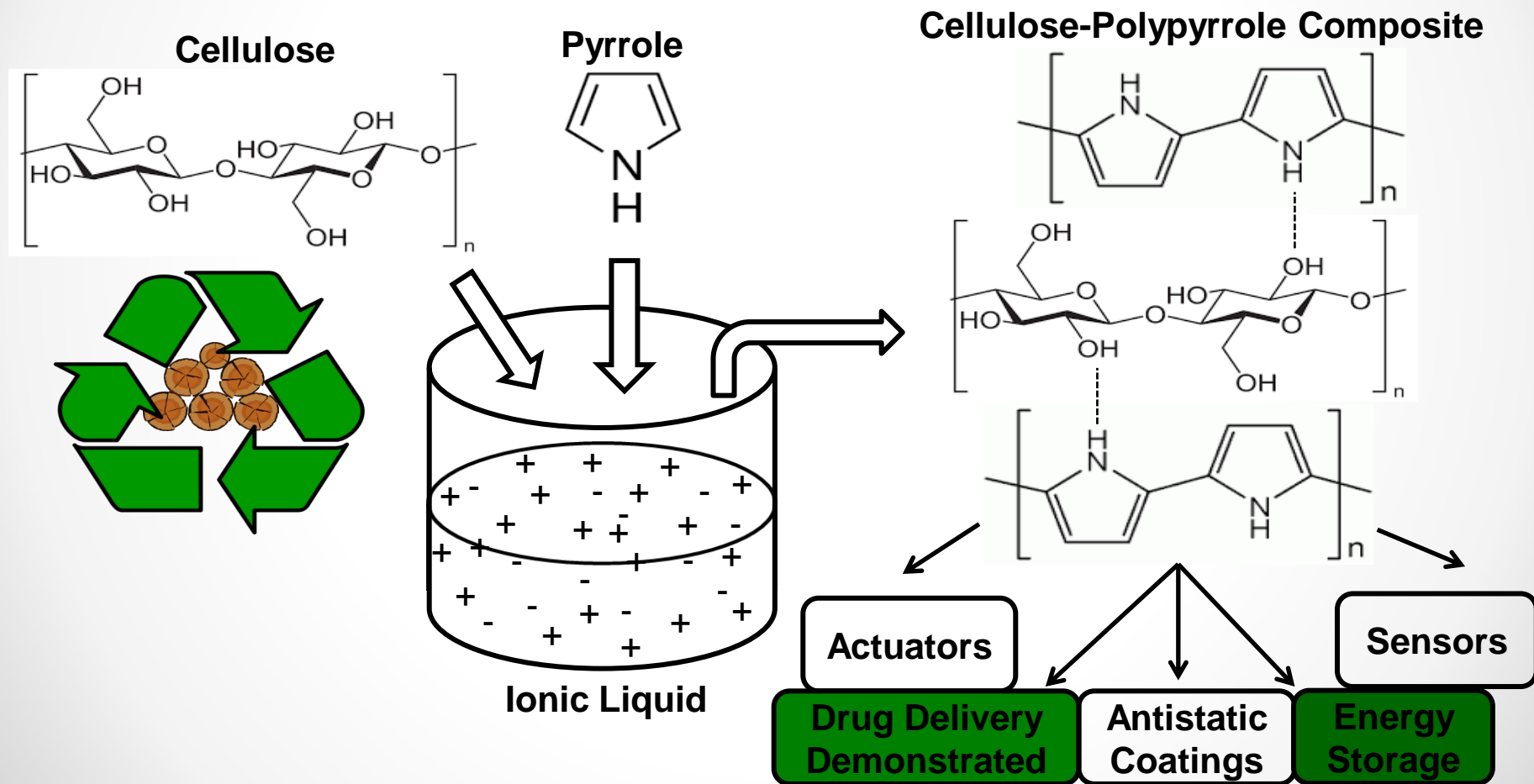
25 °C



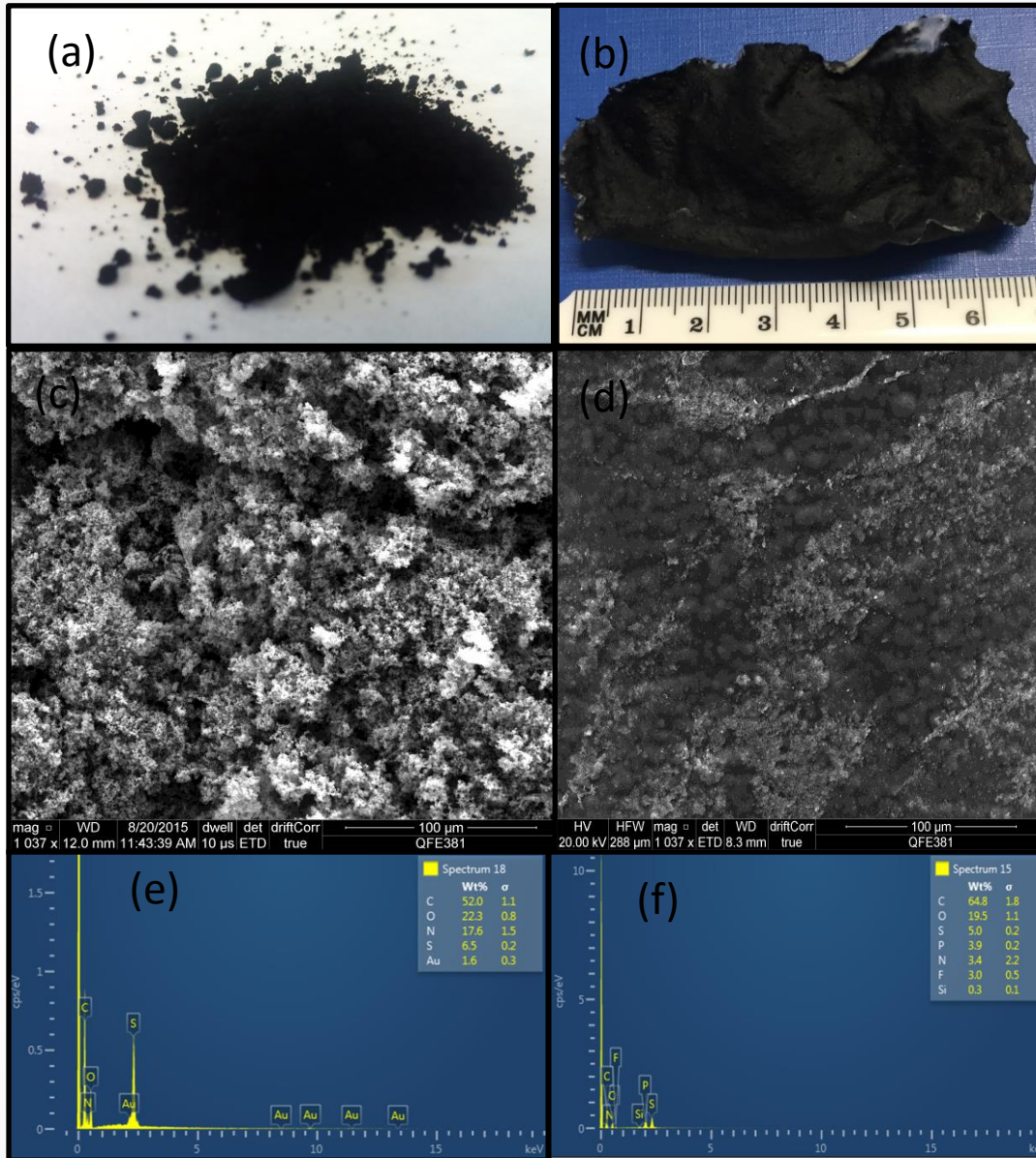
- Dissolves most of the organic and inorganic compounds
- Can be designed to dissolve hydrophobic drugs
- Active pharmaceutical ingredient based ionic liquids – no polymorphism, multifunctional option and increased bioavailability
- Ionic liquids can fight hospital bound diseases



Ionic Liquids for Conducting Polymer Processing

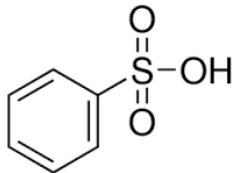
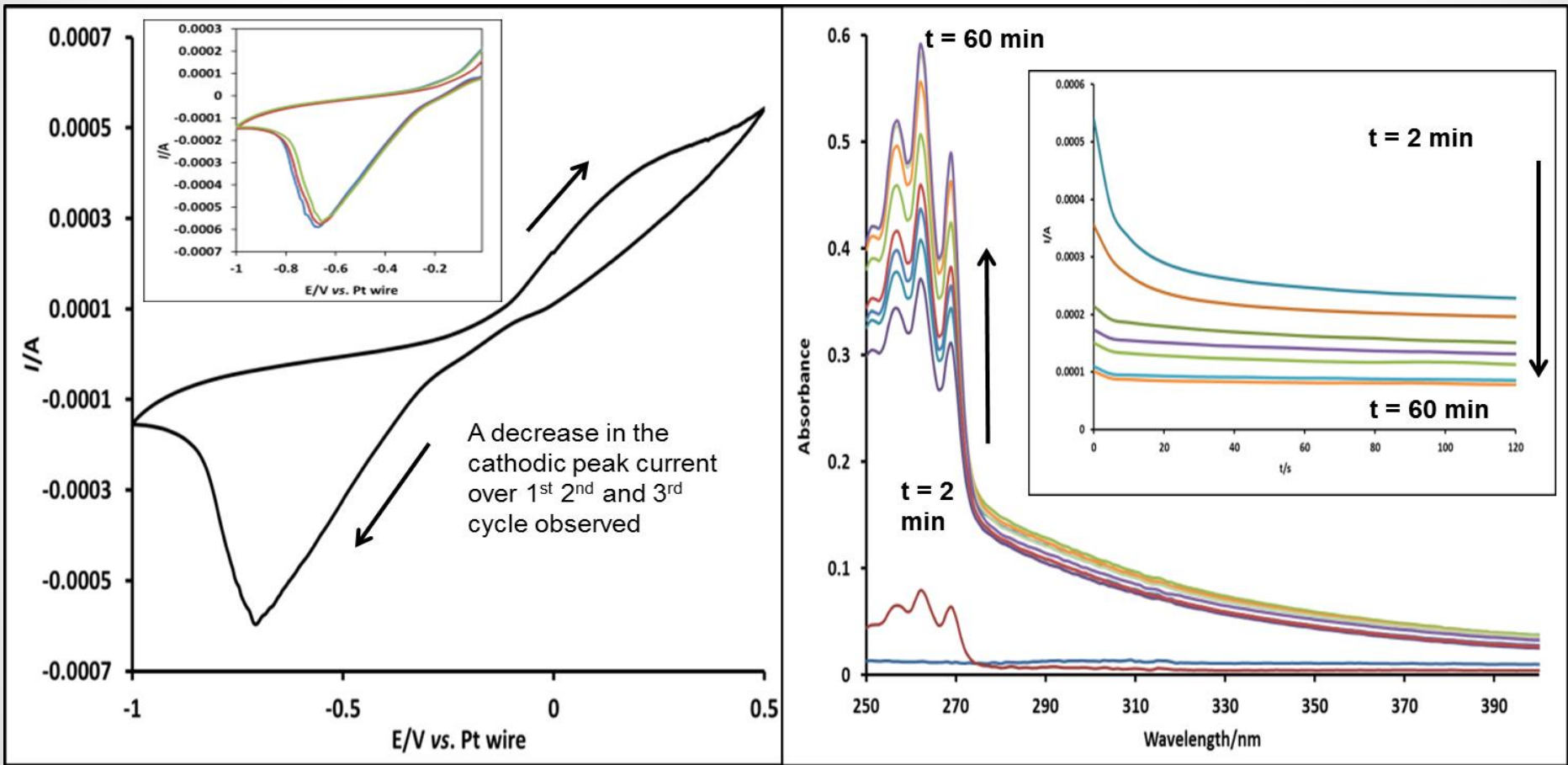


Conducting Polymer Powder



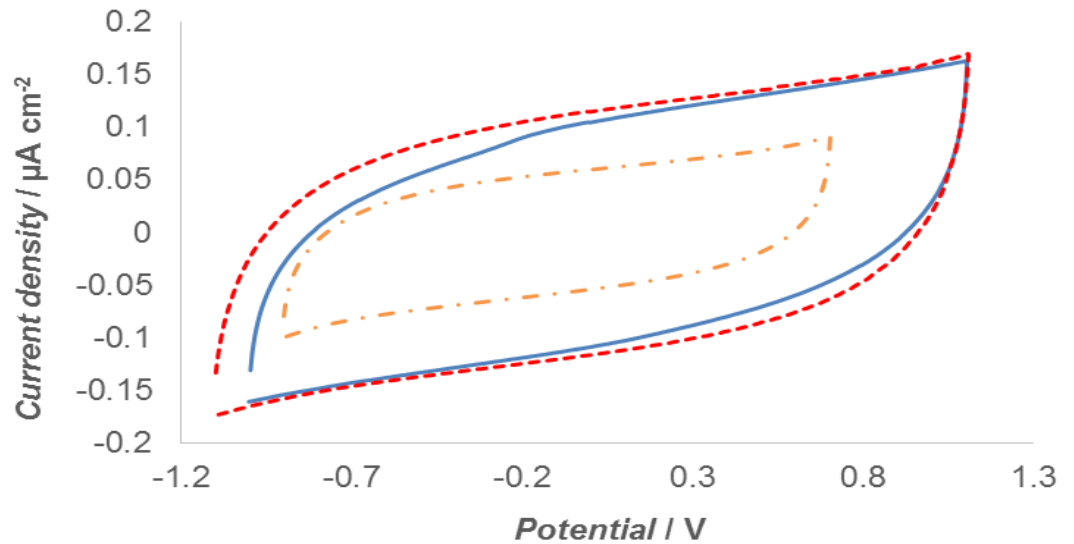
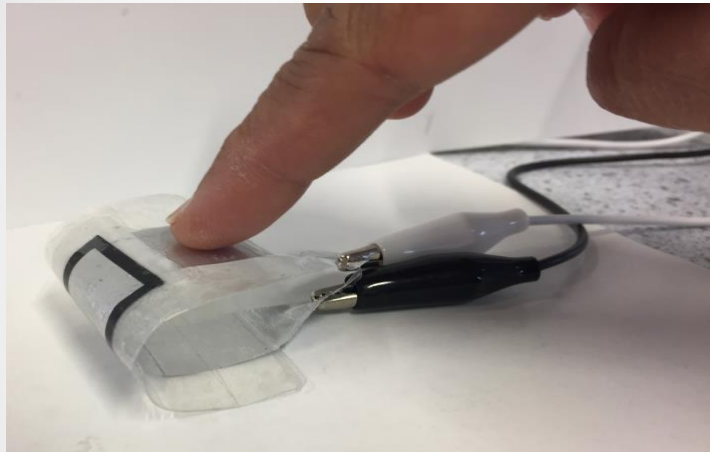
Conducting Polymer – Ionic Liquid Composite Films

Electro-activity and Controlled Drug Release

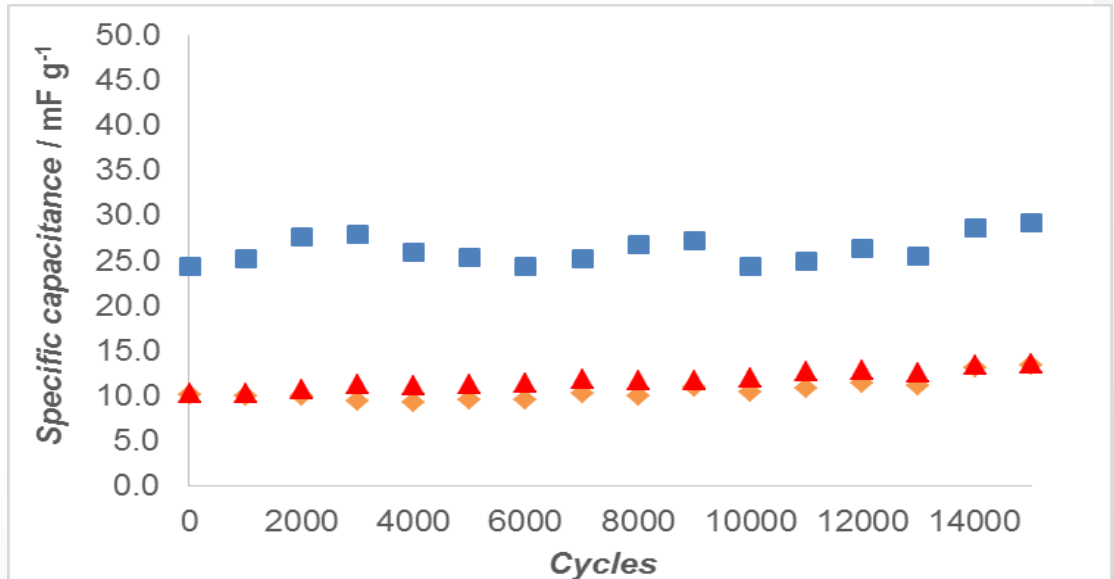


Model Drug

Powering Medical Implants



Durable Flexible Supercapacitors



M. Lorenzo and G. Srinivasan,
manuscript submitted June 2017 (under
review)

People who had some fun with electronic materials

Ms Biyun Zhu – MSci Chemical Biology project

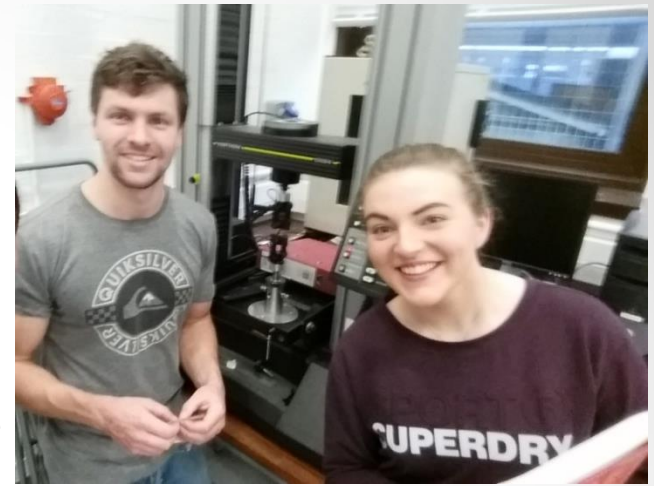
Ms Marta Lorenzo – PhD Research Chemistry

Mr Ewan Strang – MPhil Research

Chemical Engineering

Ms Nicole Dodd – MSci Pharmaceutical Analysis

Ms Claire Anderson – MEng Mechanical and Aerospace Engineering



Dr Nicola Irwin
Dr Peter Martin
Prof Steven Bell



Thank you and Questions!



Queen's University Belfast Anti-microbial Network