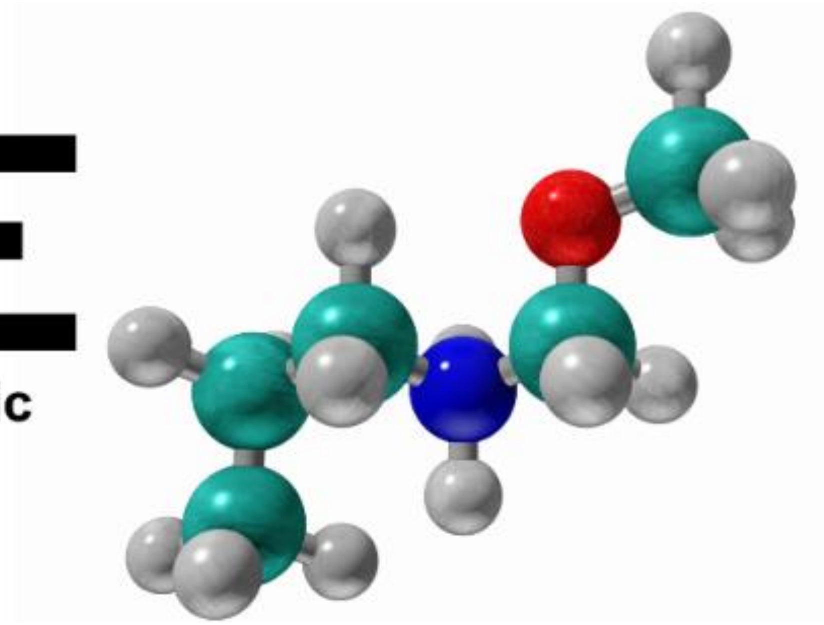


# Centre for Organic Electronics

## HSC Depth Study Material - Overview of Research

The Centre of Organic Electronics (COE) has been researching state of the art device technology for 20 years. Our core focus is on translating cutting-edge research for real world impact. As such, we partner with business, industry and government to generate products, systems and services that benefit our global community. The COE is multidisciplinary, with expertise spanning physics, chemistry, engineering, biology, health, design and communications. This depth and breadth of talent and expertise enables us to successfully manage projects from end-to-end.

These research projects include:

- Printed solar cells with Kardinia Energy
- “Lickable” insulin tests (currently creating a $12 million manufacturing plant in Newcastle) with GBS inc
- Biological interfaces, eg. artificial colour retina
- Scanning helium microscopy (SHeM)

The COE also has an Australian National Fabrication Facility (ANFF) node working with them.

## The Director of the COE is Professor Paul Dastoor

Paul Dastoor was born in London, UK. He received his B.A. degree in natural sciences from the University of Cambridge in 1990 and then moved straight into his PhD degree in surface physics, which was also completed from the University of Cambridge, in 1995.

He was a researcher in the Surface Chemistry Department at British Steel in 1994, before accepting a lectureship at the University of Newcastle in 1995. When Paul Dastoor started at Newcastle, he immediately saw the benefits in cheaper energy and started investigating conducting polymers. It was not long after this (1996) that he started to develop a paint (ink) that could conduct electricity and envisaged the use in printers.

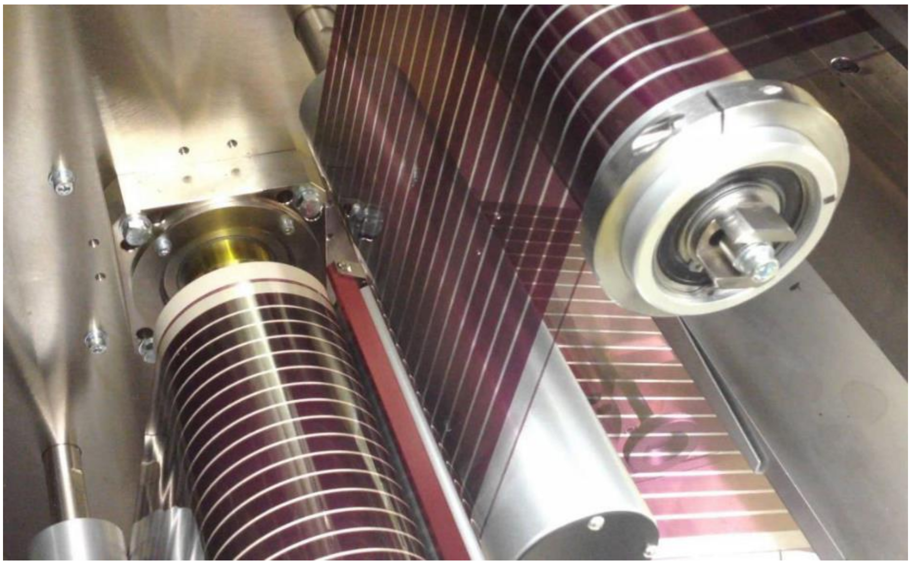
> **"Imagine a world where everyone has access to electricity, and where every surface can generate clean, low cost, sustainable energy from the sun. That's a world I want to live in," Professor Dastoor.**

He is presently a Professor in Physics in the School of Mathematical and Physical Sciences and the director of the Centre for Organic Electronics (COE) at the University of Newcastle.

His research interests involve addressing global issues as diverse as the energy crisis and diabetes using organic electronics. He is the author of over 250 peer reviewed publications attracting more than 5000 citations and has been an EPSRC Visiting Research Fellow at Fitzwilliam College, Cambridge, in 2002 and a CCLRC Visiting Fellow at the Daresbury Laboratory, UK in 2004-05 and a Leverhulme visiting professor at the Cavendish laboratory in 2019.

## Printed Solar cells using Solar Paint

Unlike the typical cells you see on roof tops which are made from silicon, printed solar cells use organic conducting polymers printed onto thin flexible plastic. In late 2018 we became the first research group in Australia, possibly the world, to embark on a commercial scale installation of printed solar. This game-changing material is incredibly low cost, ultra-thin, light weight, robust, flexible and recyclable. It's manufactured using uncomplicated, conventional print technologies along with our revolutionary electronic inks in a new form of advanced manufacturing known as functional printing.

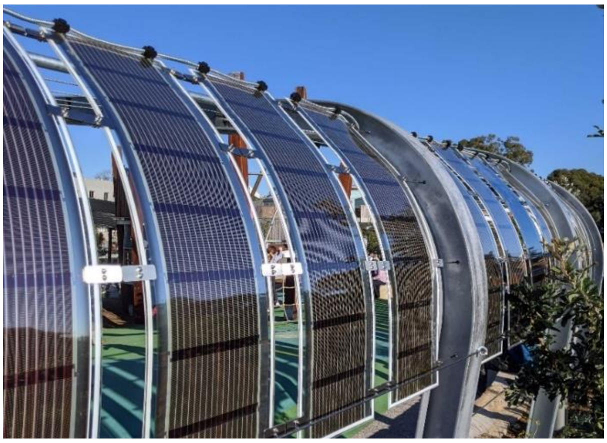


Aimed at significantly increasing the global uptake of renewable energy technologies and dramatically reducing energy bills, this technology is the result of almost two decades of research and development.

> **"The next time you're standing at the printer waiting for it to churn out your latest assignment, imagine instead that it was printing pages of sensors rather than words. Welcome to the fascinating world of functional printing, where instead of text and images, printers are producing functioning devices. The simplest example of functional printing is braille: raised dots allowing fingers to do the reading. At the other end of the spectrum are multi-layer devices that have electrical properties such as light emitting diodes, solar panels, and sensors"**

CHEP, a global Brambles company, with warehouse located at Beresfield, NSW, became the historic first commercial partner helping to explore the potential of the technology. Panels were tested for five years on top of an industrial roof to investigate weathering.

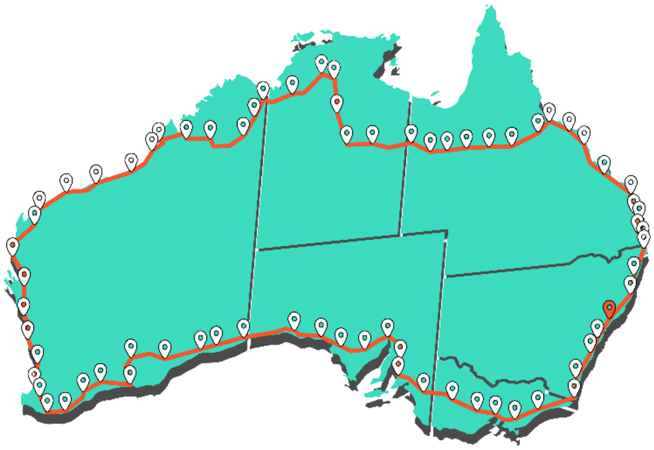
Watch the youtube video here for a visual recording of our first installation.

The first public installation of the printed solar panels was done at Lane Cove public park in Sydney in 2019. Watch Video here

https://www.smh.com.au/environment/sustainability/printed-solar-panels-a-shining-light-for-saving-energy-20200707-p559po.html

In 2022 the printed solar panels were part of the Charge Around Australia initiative with founder Stuart McBain (shown below with Tesla) (www.chargearoundaustralia.com). This project had a Tesla model 3 driving around the coast of Australia (see below) being partly charged by our printed solar panels. Along the way we visited schools with a STEM show focused on energy sustainability.

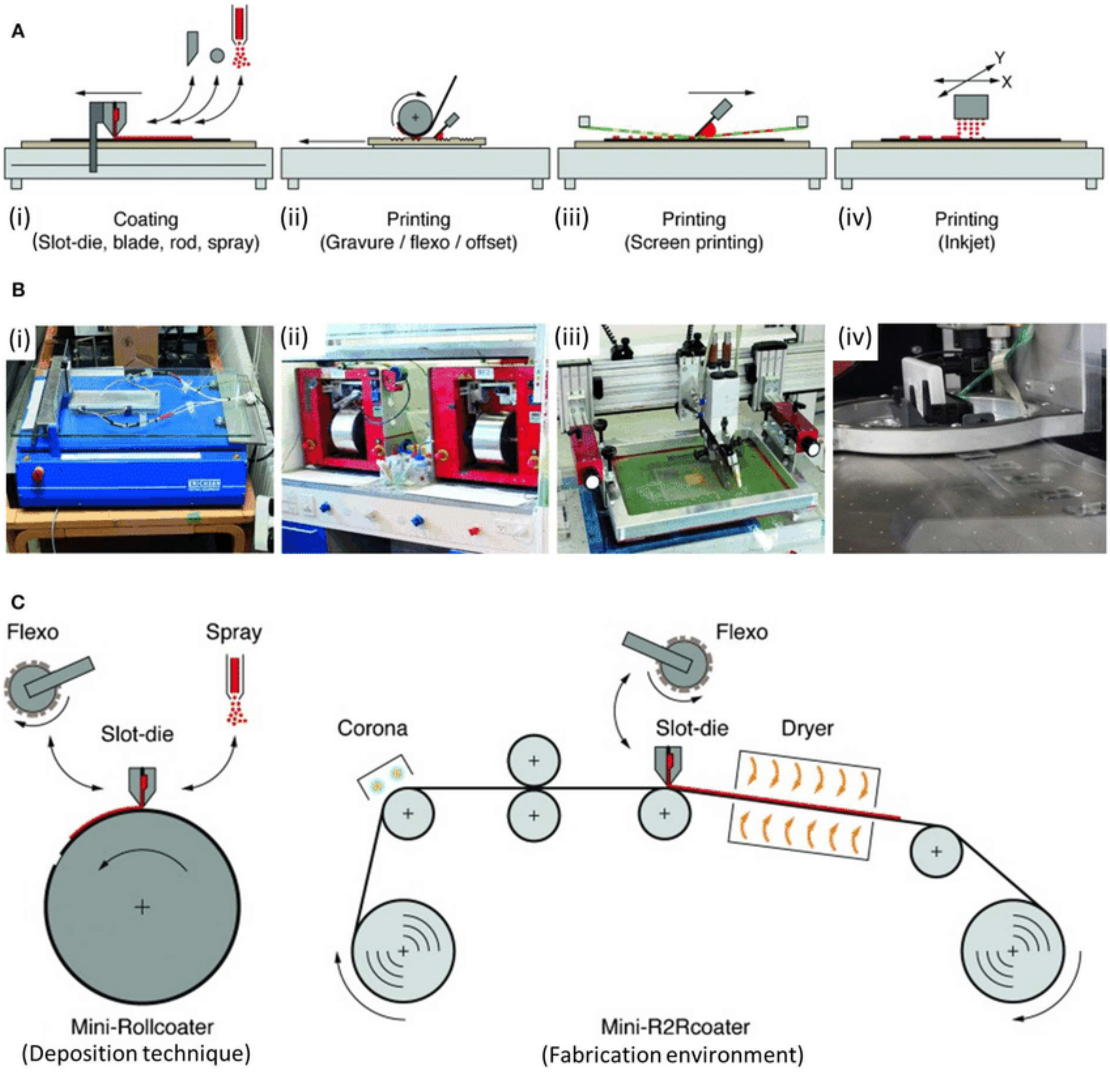
Watch videos here and here!


Go to our in-depth pages on creating single solar cells.

## Large Scale Printing

There are massive differences and consequently challenges transferring from single solar cells technology to printing with a roll-to-roll fabrication system shown below. The printing setup will help to bridge the gap between laboratory development and industrial production.

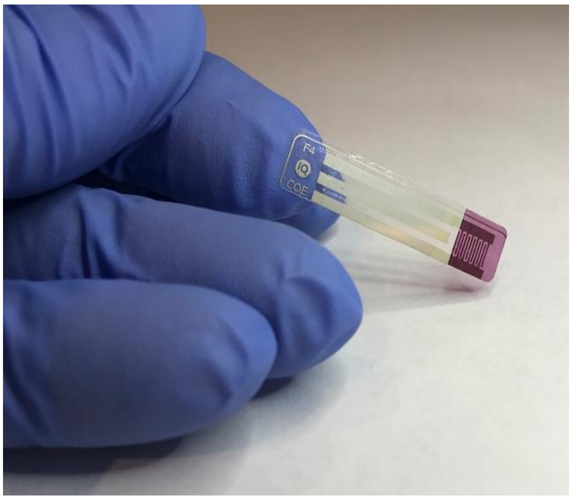
**"Our pilot-scale printing facility includes multiple roll-to-roll (R2R) systems where we can print ink layers, metal layers, and encapsulate devices". The range of printing techniques available includes slot-die coating, flexographic/gravure coating, screen printing, sputter coating, and UV-cured encapsulation (see diagram below). This broad range of techniques allows us to produce many different types of devices such as solar cells, sensors, and even explosive detonators. said Dr Ben Vaughan the facility manager at the COE**



The above image is the roll-to-roll print facility, more information is within the HSC printing technology.

# Lickable Saliva glucose test

The "lickable" saliva glucose biosensor works by coating a plastic strip with a natural enzyme that interacts with saliva, producing an electrical current. This current can be detected and measured to reveal highly accurate glucose levels that can be delivered via a smart phone app.



The Australian government has awarded the COE with $6.3million to build a manufacturing facility for the tests in the Hunter region.

The centre’s biosensor platform is also being investigated to test for tumours, immunology, hormones and communicable diseases.

See a video here of the technology

See the pages on how the glucose sensor works.

# Bioelectronics

The Centre is also developing biodevices that directly interface with living tissue so that they can directly supply information to the bodies neural network and neurons can directly trigger these devices to control them with a mere thought!

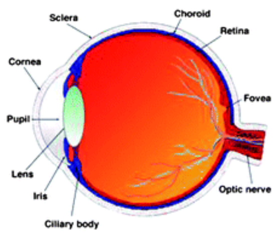
> **"A missing neuron link, which can be caused by, for example, a spinal cord injury, can cause severe problems. It can also be debilitating if neurons misfire – this can cause blindness and deafness, as well as diseases like Parkinson's and epilepsy, for which there is no cure"**

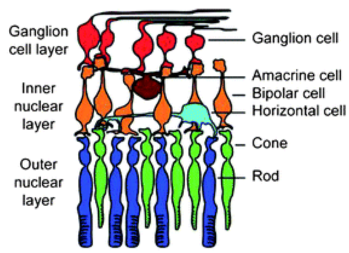
Examples include:

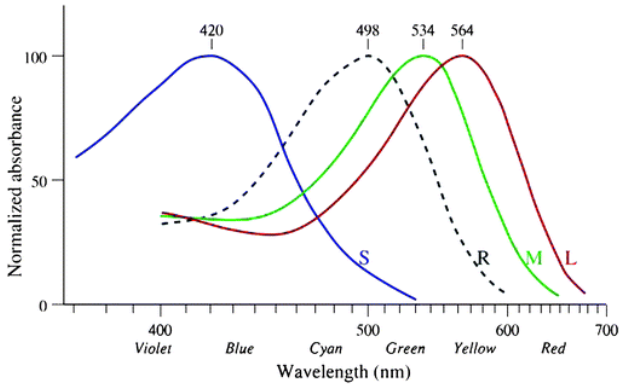
- Neurostimulation with light, i.e. Artificial retina
- Deep – Brain stimulation to treat Parkinson's disease
- Drug Delivery implants
- Nerve cell regeneration

Example: Artificial Colour Retina

The retina is the thin layer of tissue that lines the back of the eye which functions to receive light, convert it into neural signals, and send these signals to the brain for processing. Worldwide, the number of people living with vision impairment is at least 2.2 billion. This work is in collaboration with Assoc. Prof Rebecca Lim and Dr Matthew Griffith.

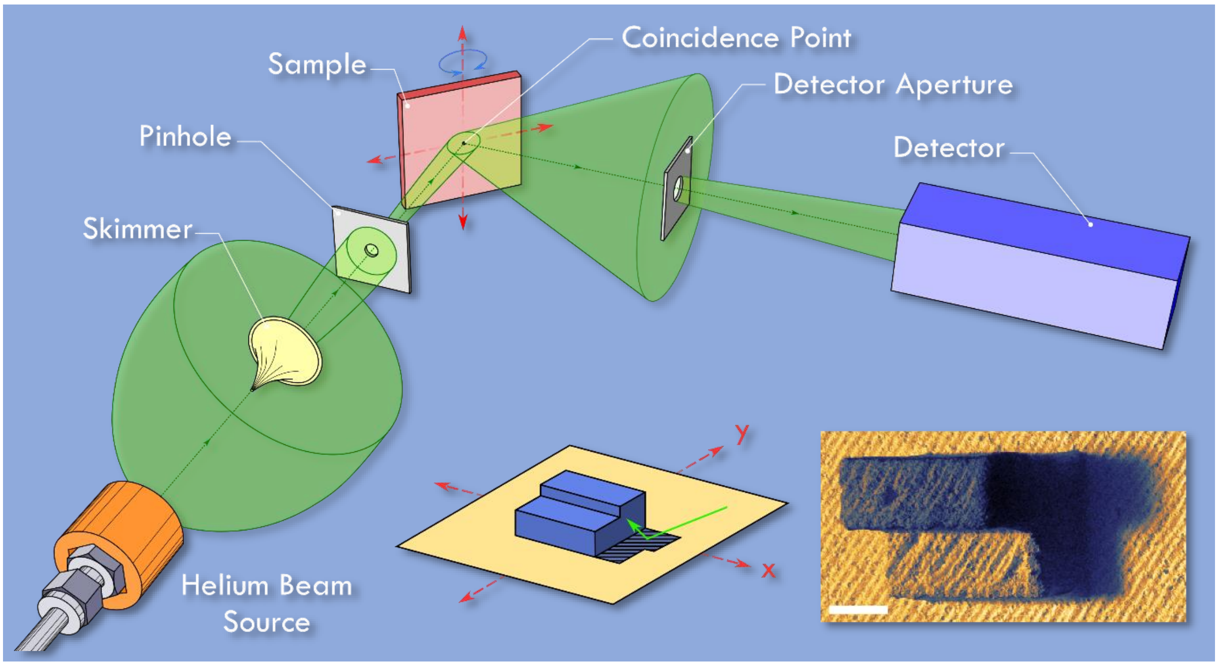


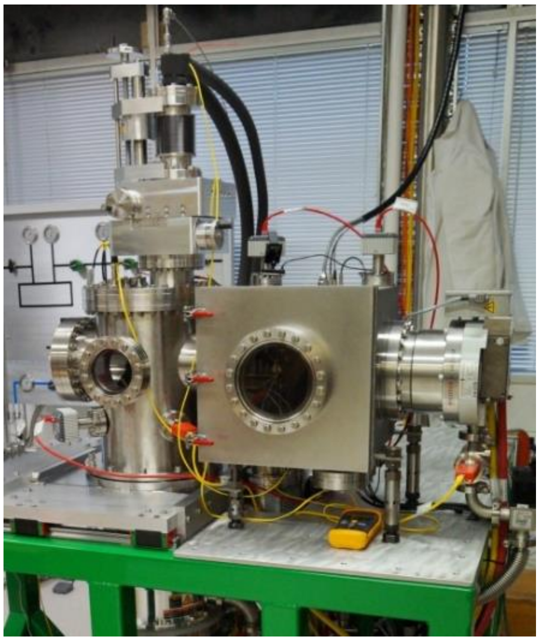




This work links to HSC Biology Module 8: Non Infectious disease and disorders – Technologies and disorders

# Scanning Helium Microscopy

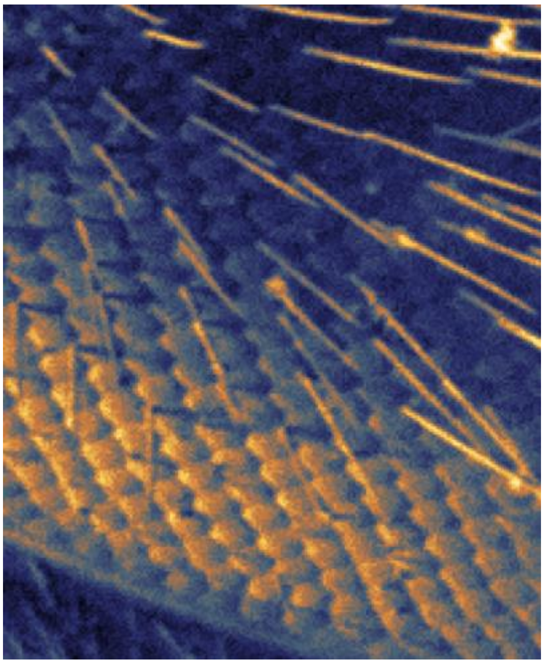


The Centre for Organic Electronics at Newcastle, in collaboration with the University of Cambridge and with support through the Australian National Fabrication Facilities (ANFF) network, has been at the forefront of the development of a new instrument known as the Scanning Helium Microscope or SHeM.

While existing microscopes utilising energetic beams of particles or light provide an excellent means of viewing structures down to the nanoscale, delicate materials are easily damaged under exposure to such beams.

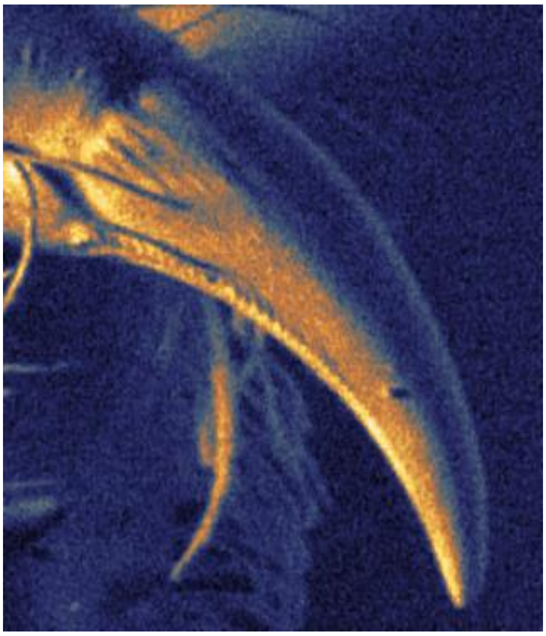
As a result, there are a range of delicate samples including biological structures (see bee eye to the right and spider fang below), explosives, or polymer layers (such as our organic solar cells) to which this technique can provide unique insight.



Apis Mellifera (Western Honey Bee)

The key to the special properties of the technique originates from the nature of the 'atom-surface interaction' (see in depth material here). A beam of neutral helium atoms can provide a probe particle where we can imagine the helium atoms as great big soft balls that bounce off the outermost electrons on the sample outermost surface. It doesn't get close to the atom core or through the first layer.

> ***"Imagine the helium atoms as a great big soft ball that bounces off the outermost electrons on the sample surface. It doesn't get close to the atom core through the first layer"***



Perhaps even more exciting than being able to image delicate materials without risk of damage are a number of potential new contrast mechanisms available to the technique. The precise way in which the helium atoms bounce off a surface also relates to the chemical makeup of the material. In the future, these mechanisms will allow SHeM to chemically 'fingerprint' different materials, meaning that we can probe not only the shape of the surface but also its composition.

Watch the youtube video here for a visual recording of our SHeM research.

COE

Centre for
Organic Electronics

For more information on

The Priority Research Centre for Organic Electronics visit:

**www.newcastle.edu.au/coe**

**or**

**email: Michael.gladys@newcastle.edu.au**

ANFF

nier

THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA