



Miniaturized sensing systems as diagnostic tools for biomedical applications

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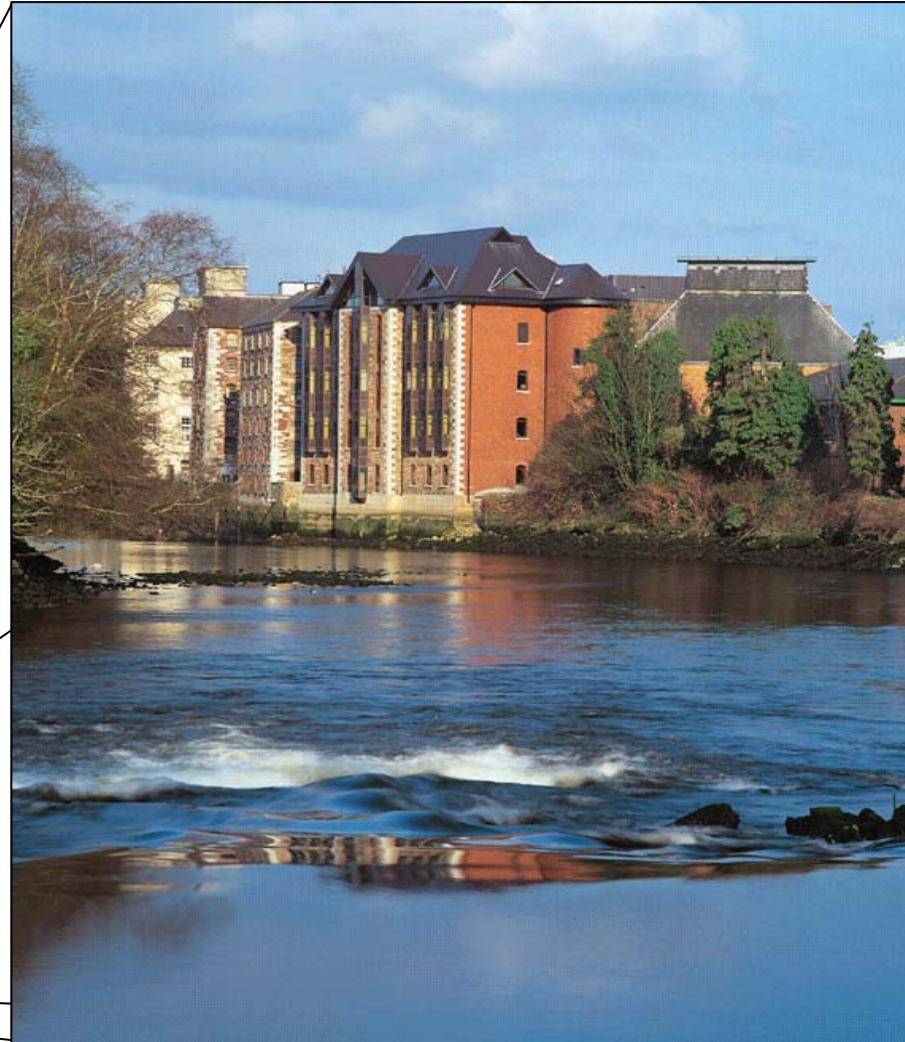
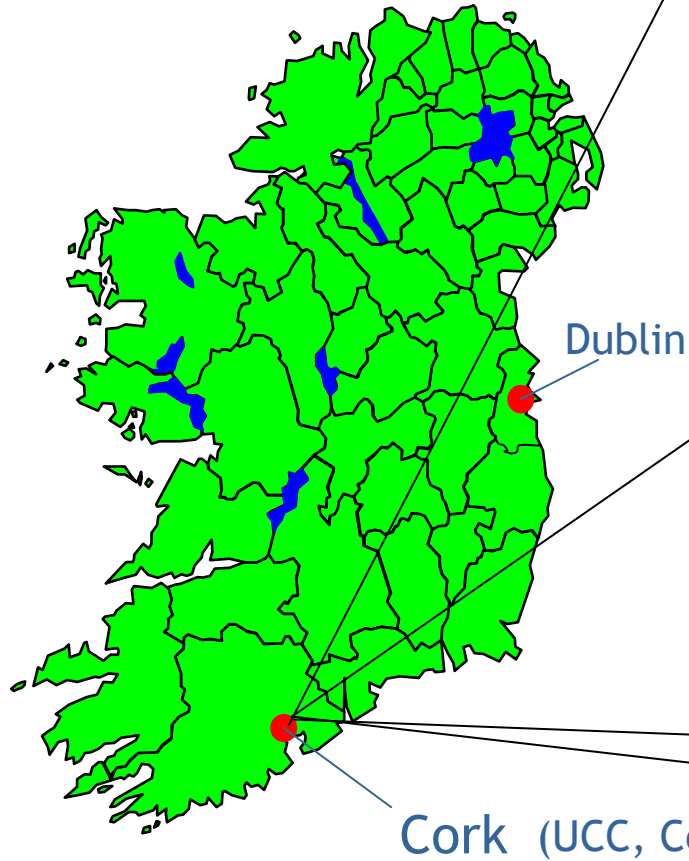
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Tyndall National Institute

- Based in Cork, at Lee Maltings

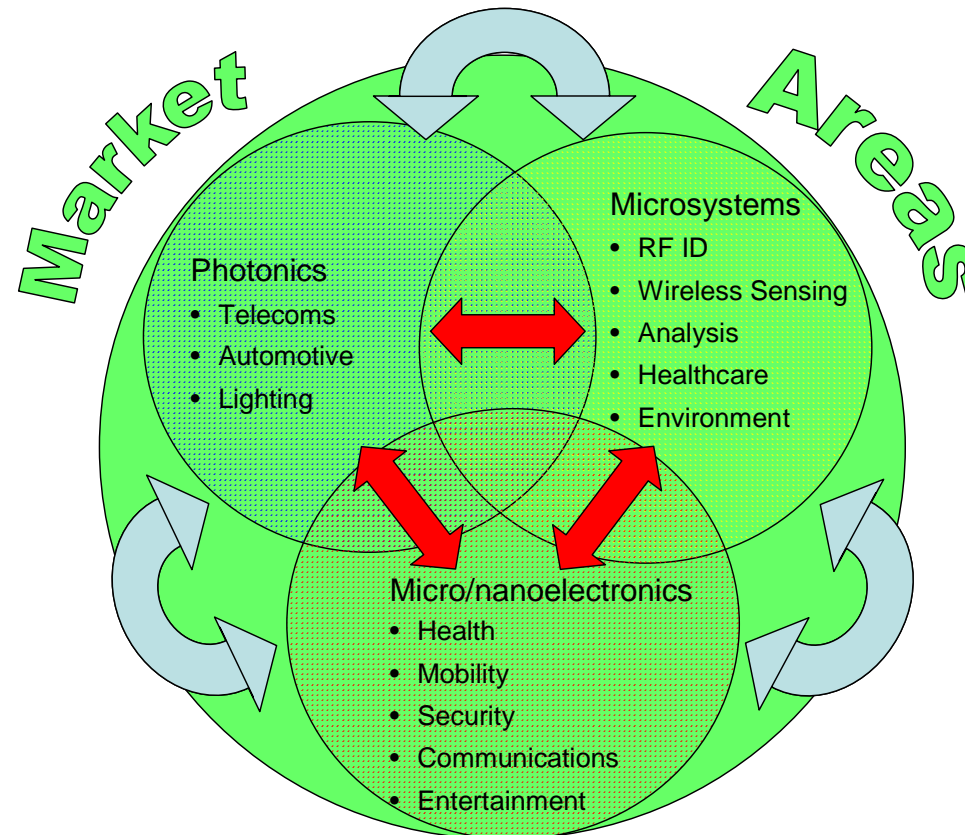




- Established in 2004 (NMRC est. 1980)
- Brings together researchers in:
 - Photonics
 - Microelectronics
 - Nanotechnology
 - Microsystems
- Originally from the National Microelectronics Research Centre (NMRC), University College Cork (UCC) and Cork Institute of Technology (CIT)
- >350 research engineers, scientists, students, interns & support staff
- Creates a critical mass of researchers in the field of ICT



Photonics - Micro/Nanoelectronics - Microsystems





Aims:

exploring the opportunities to be derived from the use of novel micro-nanotechnology (MNT) for biological and medical applications

Current areas of work:

- Development of sensor system comprising sensing device with associated data processing and instrumentation for POC testing
e.g. gut diseases
 - Complex biological fluids
- Bioactive molecule detection (proteins, peptides, drugs, etc.)

Goal:

Miniaturised devices and systems that are *simple, label-free*, and *sensitive*, and developed according to end user requirements.

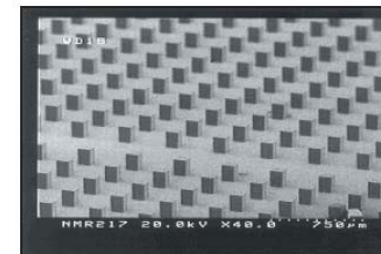
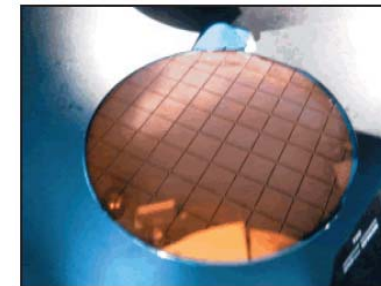


- **Development of sensor systems tailored for different applications and end-user requirements**
 - **Sensor design and fabrication: micro and nano technology**
 - **Instrumentation design and fabrication: tailored for final application, provide the complete solution, press the button get the answer**
 - **Signal processing and data interpretation methods, and implementation in user-friendly software**



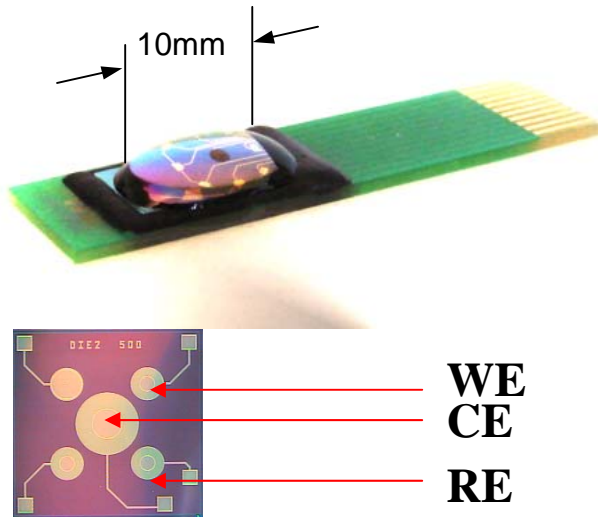


- **Direction:**
develop sensors on micro or nano scale with high sensitivity and specificity, and good reliability for the chosen biomedical application
 - Sensor designed for particular application
 - Use of biocompatible sensing and packaging materials (e.g. in-vivo devices)
 - Fouling issues with sensor surface addressed

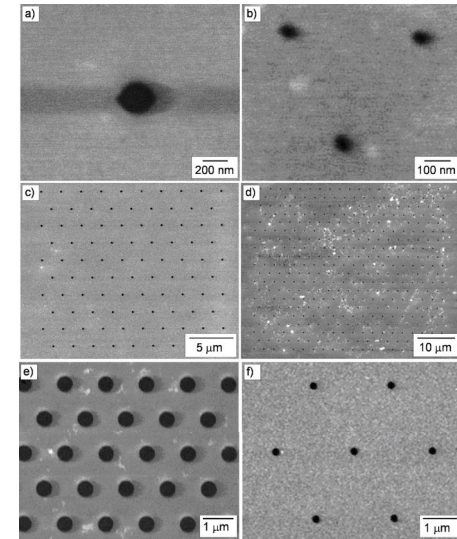
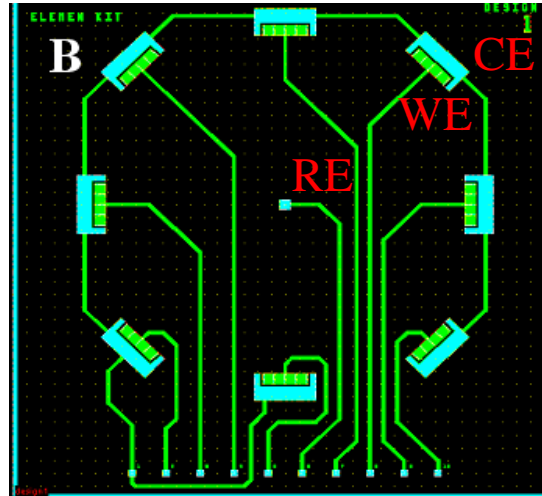




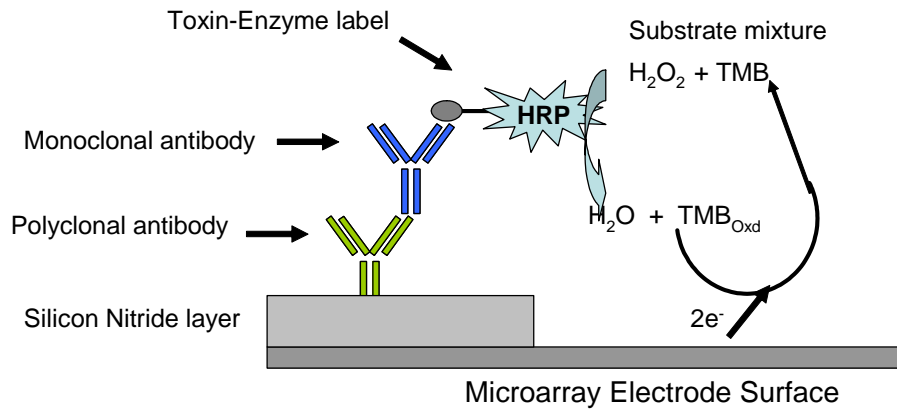
Examples of Different Sensing devices



Three electrode electrochemical sensors



SEM of nanopore arrays



**Ion transfer voltammetry across
Liquid/liquid interfaces within arrays
Biomolecule detection and extraction**

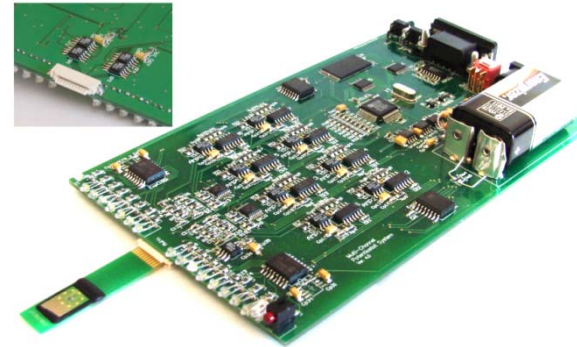
Surface modification
Aflatoxin M in milk



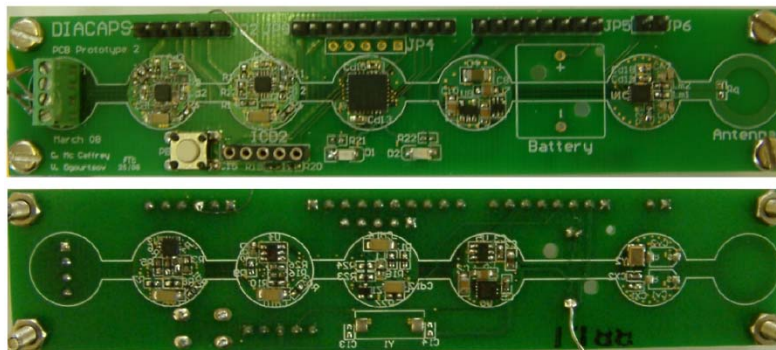
- **Direction:**
 - Miniaturised, low-power hardware for point of need applications
 - Restrictions in available size, power, necessary operating lifetime
 - Specially designed instrumentation



Example of Application-specific Instrumentation for electrochemical sensing devices



Portable system
One Application: lab benchtop testing



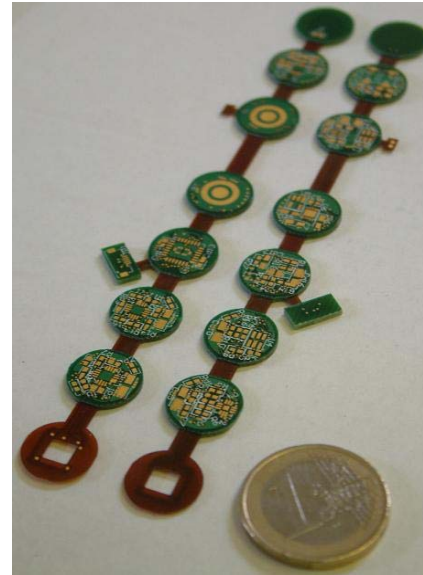
Pen-sized system
One Application: POC testing



Example of Miniaturised Instrumentation: swallowable capsule



Photograph of prototype
Capsule (13x40mm)



Instrumentation inside the capsule

- Size and power restrictions
- Wireless communication
- Sensing dies interconnected within body of capsule via flip-chip packaging
- Instrumentation on flexible and semi-flexible substrates



Signal processing and data interpretation

- **Direction:**
 - Develop tailored signal processing methods for different end-users requirements
 - Implementation in a user-friendly software
- Standard signal processing methods are often not sufficient in extracting the important information from complex biological samples
- Specific information is required according to the type of application and end-user needs
- Compensate for Biological Matrix effect: mix of many active species/analytes with complex background signal behaviour



- *Collaborate in area disease diagnostics based on specially developed sensing systems*
- Current limitations with tools available to medical community
- We can deliver the complete system
- Miniaturized, easy to use, end-user driven
- Who do we want to collaborate with? End-users of the technology, researchers currently working on sensing systems for different diseases.



Thanks for listening!

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