Electrochemical Materials & Energy

Electrochemical materials are widely used in advanced technology such as electronics, energy and sensor applications. We are investigating novel routes for micro to nanoscale metal, alloy and laminate materials that can complement typical thin film deposition techniques like physical vapour or atomic layer deposition. For ICT applications we are investigating seed and barrier layers, electrical interconnect and magnetic materials processing on planar and 3D substrates.

Recent developments have included the activation of insulators and electroless materials processing for lamination of magnetic alloys on silicon substrates in power supply on-chip (PwrSoC) applications.

![X-ray of magnetics on silicon structure with Cu racetrack conductors wrapped with a NiFe core](image)

Portable electronic devices rely on electrochemical energy sources. Next generation devices and those in the 'Internet of things' will require more advanced energy storage and hybrid energy harvesting solutions.

We are developing new materials, combinations and routes to fabrication for enhanced energy storage microbatteries on-chip. The research focus is on materials and architecture simulations, advanced materials deposition and electrolyte optimisation for integration in the advanced fabrication solutions.

![Generator-collector mode electrochemistry at nano interdigitated electrode arrays](image)

Micro and nanoscale electrochemical sensors are also under development at Tyndall. Single or electrode arrays have been designed and fabricated that can be post-processed for optimised sensing applications. A key initial step is device simulation prior to fabrication to determine the optimum design.

Recent developments have seen the use of nanoporous materials in microelectrode arrays for liquid and gas analyte sensing and, in collaboration with the Nanotechnology Group, nanointerdigitated arrays for generator collector-mode electrochemical sensors with enhanced sensitivity.

![Diffusion simulation of generator-collector mode electrochemistry at nano interdigitated electrode arrays](image)
Diffusion simulation of generator-collector mode electrochemistry at nano interdigitated electrode arrays.

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Related Publications

  Authors: Ricky Anthony, Cian O’Mathúna, James F. Rohan

- Frontiers of Cu Electrodeposition and Electroless Plating for On-chip Interconnects. Copper Electrodeposition for Nanofabrication of Electronics Devices pages 99 to 113 (2013)
  Authors: James F. Rohan, Damien Thompson

- Characterisation of the electroless nickel deposit as a barrier layer/under bump metallurgy on IC metallisation. Microelectronic Engineering volume 65 issue 1-2 pages 77 to 85 (2003)
  Authors: James F Rohan, Gerald O’Riordan

- Electroless thin film CoNiFe-B alloys for integrated magnetics on Si. Electrochimica Acta volume 54 issue 6 pages 1851 to 1856 (2009)
  Authors: James F. Rohan, Bernadette M. Ahern, Ken Reynolds, Stephan Crowley, David A. Healy, Fernando M.F. Rhen, Saibal Roy