



SMART Microsystems



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Introduction

Microsystems technology is a significant element of the UK manufacturing industry with larger core companies employing 43,000 with over £2.3bn p.a turnover. Many research groups and companies in the UK are involved in the development of microsystems technology. However, the Institute of Integrated Systems (IIS) between Heriot Watt University, UK Astronomy Technology Centre (ATC) and the University of Edinburgh is one of a very small number that have the capability to integrate this technology with silicon based microelectronics.

Collaboration between academia and industry will be encouraged by the SMART microsystems project within the IIS. This project will aim to solve many of the problems associated with the integration of novel and exciting technologies by taking advantage of the unique synergies and capabilities within the IIS. The development of these integrated microsystems will have great potential for knowledge transfer and commercial exploitation. This initiative will have significant impact, benefiting research, industry and the wider community

Objectives

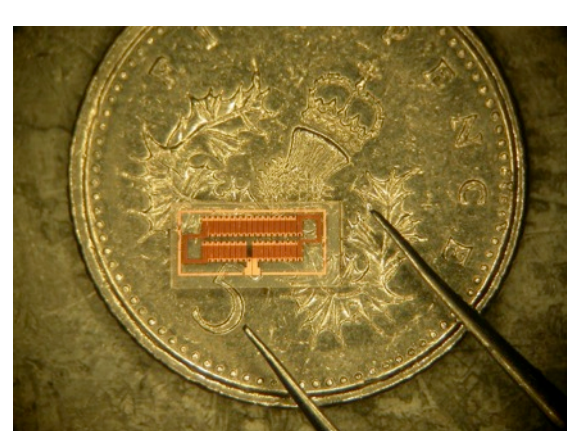
This flagship project will

- Build upon the IIS partnership by extending existing industrial collaborations across the UK to those interested in innovation in the area of integration between advanced electronics and microsystems.
- This cluster will provide a route back into mainstream production for UK microfabrication within the worldwide microelectronics sector by bringing together designers, technologists, scientists and users to form a new network capable of exploiting the novel technologies developed.
- The increased critical mass will enable opportunities to be identified for the commercialisation of the material and technology developments across a wider range of applications.
- It will provide the opportunity to develop collaborations both with and between other MNT companies
- A platform for the IIS to position itself into a world leading research centre in the field of microsystems integration by the post-processing of CMOS.

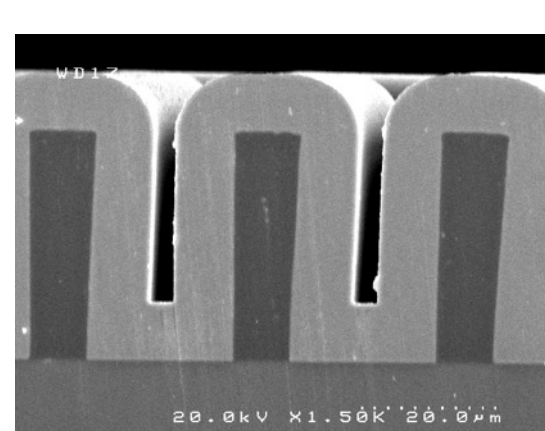
Technologies

The project will research, develop and validate technology in key areas related to the post processing of CMOS (Complementary Metal Oxide on Silicon) technology wafers. These areas include:

Magnetic materials – CMOS-compatible power management solutions are a disruptive and significant new opportunity. National Semiconductor are working with the SMART microsystems project and are investing in their Greenock facility to develop technologies for the controlled deposition of thick magnetic materials on to integrated circuits (ICs) and integrate sensing elements alongside these magnetic components.

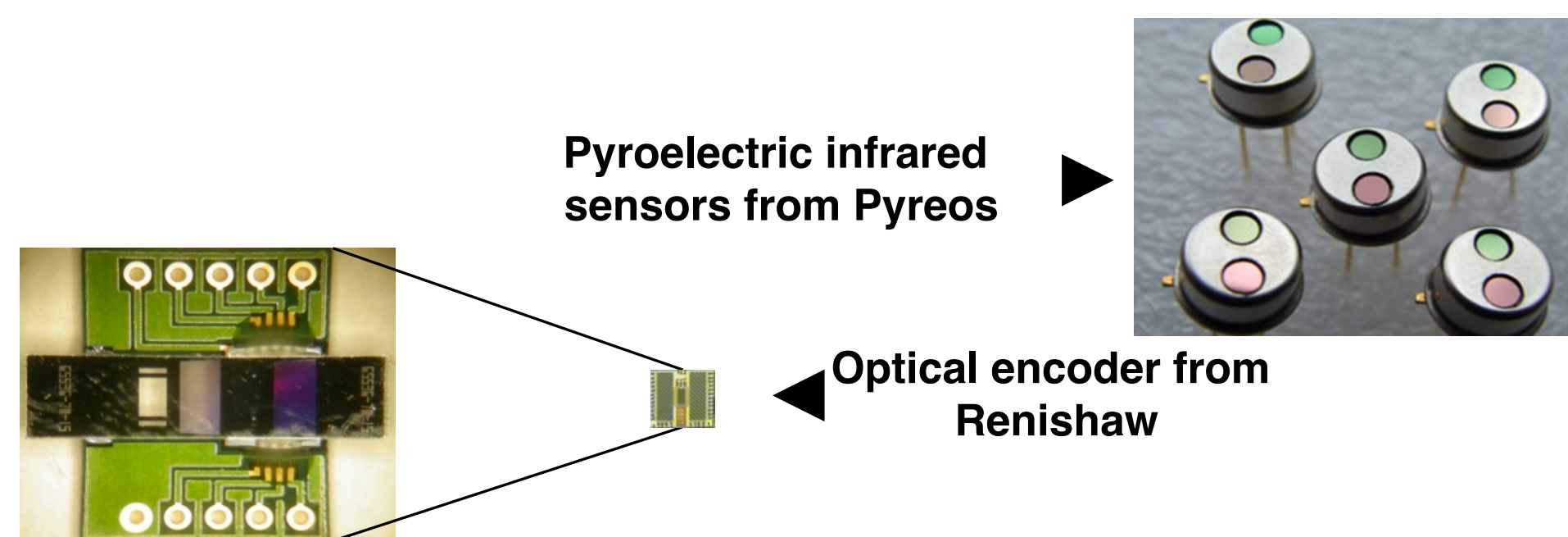


DC-DC converter produced by a three layer LIGA process

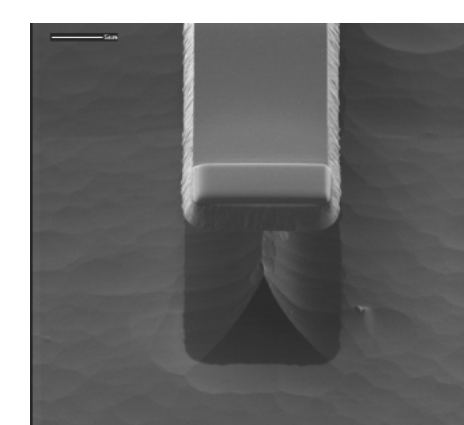


Electroplated Permalloy over SU-8 polymer moulds

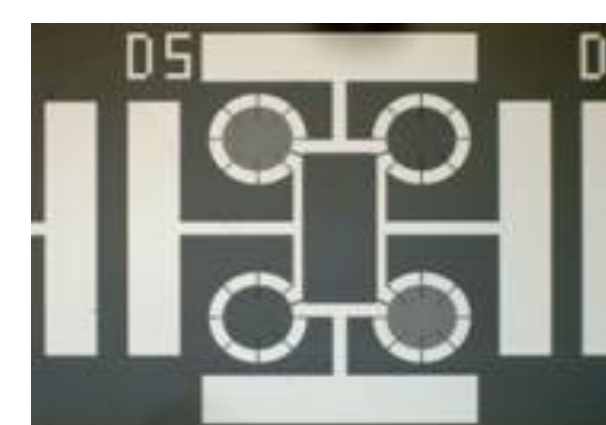
Integration of sensors with CMOS integrated circuits – Develop CMOS integrated optical encoders, pyroelectric infrared sensors and microphones with Renishaw, Pyreos and Wolfson Microelectronics respectively.



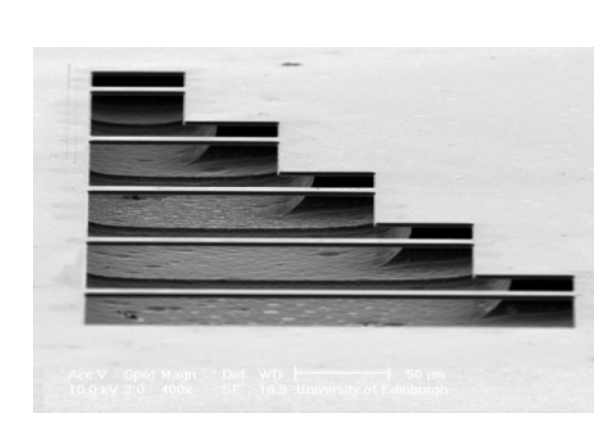
Integration of novel materials with silicon carbide - Only four organisations have been identified who are heavily investing in work on silicon carbide integrated circuits. Raytheon UK is one of these and the SMC has previously been involved in some of their SiC integrated circuit processes developments. The integration of sensors and MEMS into Raytheon's SiC ICs provides significant commercial opportunities.



FIB tuned SiC resonator

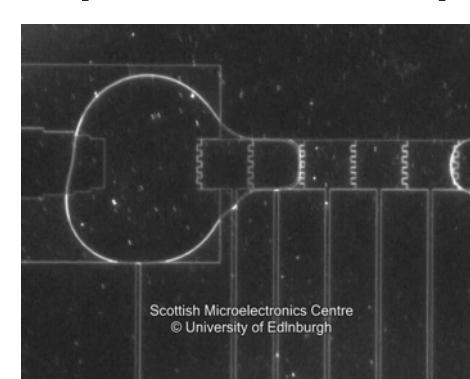


SiC pressure sensor



SiC beams and cantilevers

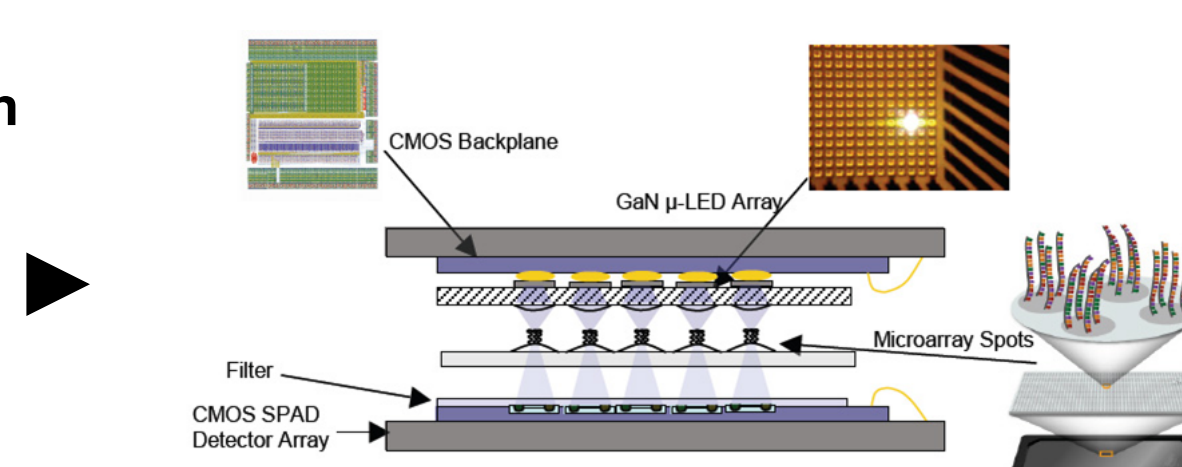
Novel Sensors and Actuators for Microfluidics– Recent integration of the world leading low voltage EWOD (electro-wetting on dielectric) technology and surface acoustic wave (SAW) sensor technology developed by the IIS has enabled the production of microfluidic devices capable of improved droplet manipulation .



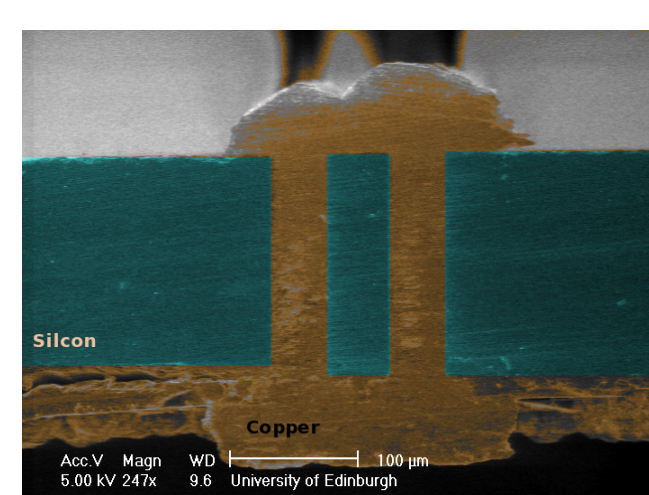
EWOD electrode arrays capable of transporting and manipulating droplets

Further integration of these technologies with optical sensor arrays and CMOS electronics will produce a microfluidic platform for the analysis and actuation of droplets and their contents suitable for biomedical applications.

Conceptual schematic of an integrated EWOD, CMOS platform utilising time resolved fluorescence imaging for biomedical analysis



3D Integration - Manufacture of high aspect ratio, through-wafer vias for 3D integration of silicon ICs with optoelectronic and microfluidic components

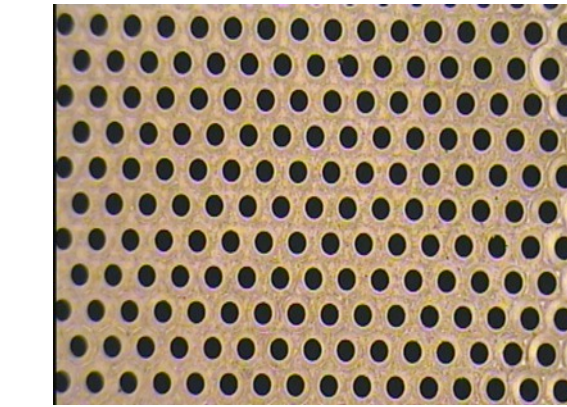
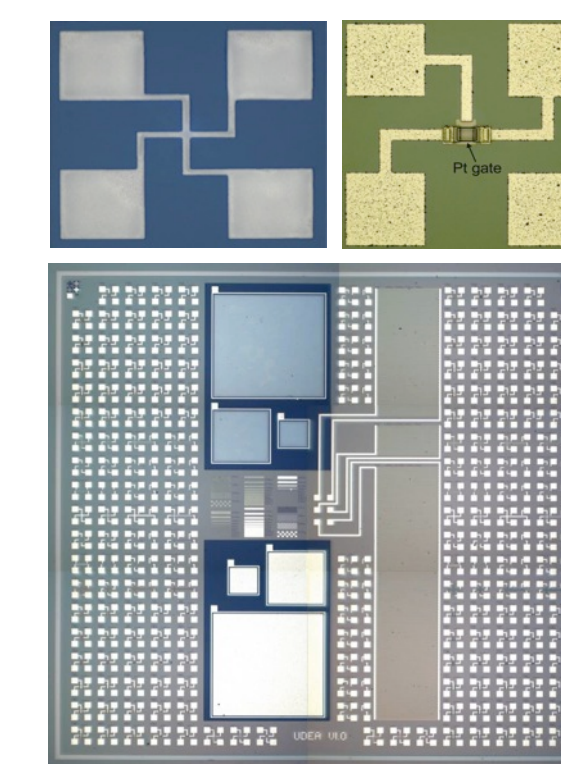


Coloured SEM image of copper through-wafer vias

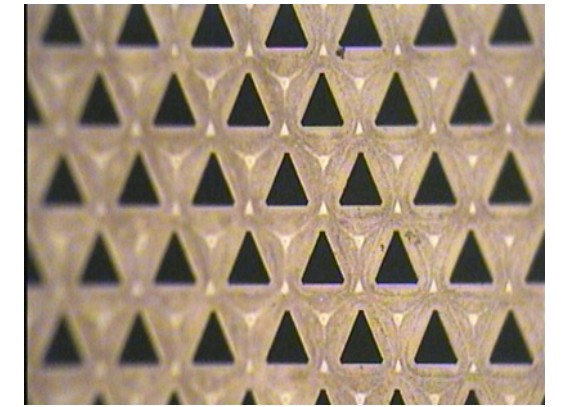


Microcolumn bumping for fine pitch flip-chip bonding

Printing technology - Utilisation of screen-printing, inkjet printing and stencil technologies to enable direct integration of printed electrodes on microelectronic circuitry. This work will build on the state-of-the-art stencil technology developed at Heriot-Watt University, which resulting in spin-out of Microstencil as well as proof of concept work carried out at the University of Edinburgh that supported the spinout of Ceimig,



Sub-100 micron ultrafine pitch microstencil patterns



Electrical test structures fabricated with novel photosensitive organometallic materials from Ceimig

Potential Economic Impact

- Microsystems technology is a significant element of the UK manufacturing industry with larger core companies employing 43,000 with over £2.3Bn p.a turnover.
- SMEs dominate the microsystems technologies sector and employ around 400,000 people in the UK. 60% of these SMEs reported less than £1M turnover p.a while 5% have a turnover between £5 and 10M.
- This project has the potential to provide smaller companies with access to manufacturing expertise that could propel them into significantly larger players.
- The UK has a strong position in developing integrated microsystems which with the national emphasis on high value manufacturing makes this project extremely timely.
- The vision is to sustain and grow technologies for high value manufacturing providing great potential for exploitation that will significantly impact the UK economy both financially and in terms of knowledge and expertise.
- Fabrication of CMOS wafers predominantly now outsourced to foreign foundry facilities. Microsystems integration through the post-processing of CMOS potentially enables key IP to be retained in the UK forming a barrier of entry to competitors.
- The SMART microsystems collaborates with 7 multinationals, 6 SMEs and 2 trade organizations to develop and commercially exploit these potentially innovative technologies.

