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Poster Abstracts

Jack Hoyd-Gigg Ng
Assembly and Packaging of Integrated Ultrasonic Transducers for Medical Applications
Compact, high density electrical interconnections are required for micro-electrode array which drives the piezoelectric crystal in the next generation ultrasonic transducers. Two demonstrators (1) a needle transducers and (2) a high intensity focused ultrasound (HIFU) transducer are being developed from a collaboration between Heriot-Watt University and University of Dundee. The high resolution and performance demanded by these state-of-the-art devices for imaging and therapy such as tumour and cancer treatments means that new assembly and packaging techniques are required to exceed the limits of of pitch sizes and density that current industrial technologies could achieve. This project is in its early stage and any inputs from the IIS partners will be much welcomed.

David Watson
UV Direct-Writing of Metals on Microstructures
Under investigation at present is a process for forming silver nanoparticles within a modified polyimide substrate. This incorporation of the metal yields improved adhesion while enabling linewidths down to a few microns. The project then aims to explore methods of adapting this technique to a broader range of substrates, from other plastics similar to polyimide to more traditional glass and silicon wafer substrates and to realise a 3D direct writing fabrication process.

Deirdre M. Kavanagh, GuiseppeSchiavone and Prof. Marc P.Y. Desmulliez
Design, Simulation and Fabrication of a MicroscaleMagnetophoretic Device for the Separation of Nucleated Red Blood Cells from Maternal Blood
Magnetic separation of a pure cell population from complex biological samples is a common technique performed in bioresearch. The main components of cells, water, proteins, phospholipids and DNA, render a cell diamagnetic with no intrinsic magnetic dipole. In order to achieve separation magnetic particles coated with cell binding molecules are traditionally used. There are 2 types of cells that are an exception to this, the first magnetotactic bacteria; contain tiny particles of iron, the second are deoxygenated red blood cells (deoxyRBCs). Chemical interactions within the ironing containing protein haemoglobin are responsible for the magnetic behaviour of deoxyRBCs. These cells have a paramagnetic behavior in plasma and can be separated without the need for magnetic particles. In spite of this intrinsic property of RBCs, large-scale magnetic separators have had limited success as the magnetic fluxes that these systems generate are too small to have an effect on non-labeled biological cells. This work focuses on the design, simulation and fabricationof a micro-magnetic separator for the enrichment of fetal nucleated RBCs from maternal blood for non-invasive prenatal diagnosis. Fetal cells in maternal circulation have great potential for prenatal diagnosis, however their rarity (1cell/ml of maternal blood) has made their separation extremely challenging. The device consists of a micron-sized channel fabricated in a biocompatible polymer, containing one inlet and three outlets. Close to the channel wall are electroplated permalloy elements. The external magnetic flux is provided by the permanent magnets situated on either side of the channel. This system aims to produce a high enough magnetic flux gradient to separate cells by exploiting their native magnetic susceptibility without the need for magnetic labels.

Suzanne Millar, Marc Desmulliez and Stewart McCracken
Ultra Low Leak Detection methods for MEMS packaging
Many MEMS require hermetic packaging to protect the active MEMS component from contamination for optimum performance. For a typical MEMS package volume a leak rate of $6e^{-16}$ $atm.cm^3.s^{-1}$ is necessary to guarantee hermeticity for up to 5 years. Current test methods are not capable of measuring the ultra low leak rates that adversely affect some MEMS. The limitations of the traditional test methods are described and potential leak detection methods for MEMS using FTIR, Raman spectroscopy and in-situ test structures are presented.

Mansuor Alghane
Surface acoustic wave streaming in microfluidic system
Recently, there is a significant advance in the production of micro-devices for manipulation of small amount of fluids as well as handling small components of materials like reagents. These devices have important and effective applications in microbiology and micro chemical sciences, which allow integration of different processes in very small, complex and accurate micro device such as Lab-on-chip. One major problem of Lab-on-chip is the difficulty in pumping and mixing process where there is no conventional pumping system can work effectively in micro-scale. In order to overcome this problem, novel type of pumping system has been

investigated; for example, surface acoustic wave (SAW). In this poster, an experimental study and numerical simulation of SAW microfluidic applications are carried out, and the effects of SAW power and fluid property on droplet pumping, mixing and particle separation are studied. Microfluidic 2D numerical simulation for the SAW streaming has been performed. In comparison between the simulation and experimental results, good agreement is obtained.

Carolina Mateo-Segura
Periodic planar 2-D Leaky Wave Antennas (LWA) have attracted significant interest in recent years due to their high gain and efficiency performance. Their typical implementation consists of a partially-reflecting surface (PRS) forming a half-wavelength resonant cavity with a ground plane. More recently, a planar artificial magnetic conductor (AMC) ground plane has been proposed as a means to reduce the profile of such antennas to quarter wavelength or lower values. This poster presents a fast and accurate analysis and synthesis technique for high-gain subwavelength 2-D Fabry-Perot leaky-wave antennas (LWA) consisting of two periodic metallo-dielectric arrays over a ground plane. Full-wave method of moments (MoM) together with reciprocity is employed for the estimation of the near fields upon plane wave illumination and the radiation patterns of the LWA. This yields a fast and rigorous tool for the characterisation of this type of antennas. Design guidelines to tailor the antenna profile, the dimensions of the arrays as well as the antenna directivity and bandwidth are shown. A study on the radiation efficiency for antennas with different profiles is also presented. Furthermore, this technique is employed together with array theory to extract the complex dispersion of such antennas. A comparison with a transverse equivalent network (TEN) model is given for the case of a $\lambda/4$ profile antenna. The technique can be used to obtain the complex dispersion for antennas with even lower profile in which the TEN model results inaccurate.

J. Sanz-Fernández, G. Goussetis, R. Cheung
Multiband and Tunable Frequency Selective Surfaces (FSS) at Infrared
Frequency selective surfaces (FSS) have received significant attention for their use as stop/pass-band filters at infrared frequencies. They offer competitive alternative to thin/thick film filters and dichroics across the submillimeter and THz bands. The quality factors of THz FSS, described by their energy stored, dissipated and radiated, are presented by using full-wave analysis and circuital models. Recent advances in the design, fabrication and measurements of FSS with multiple resonant bands and tunable FSS by micro-electro-mechanical systems (MEMS) are also presented.

Yifan Li
This poster presents the design and fabrication of test structures specifically designed for the characterisation of two distinct digital microfluidic technologies: Electro-Wetting On Dielectric (EWOD) and Surface Acoustic Wave (SAW). Test chips have been designed that includes structures with a wide range of different dimensions and will provide the capability to characterise enhanced droplet manipulation and other integrated function. These include the use of EWOD to anchor droplets while SAW excitation is applied to perform mixing.

Stuart Brodie
Microfluidics based Lab-on-Chip Biosensor
Biosensors have become a rapid area of development with the promise of improved detection of diseases such as cancer and uses in personal health monitoring and drug development. Several key technologies have become widespread in the area for fluid transportation and bio-sensing such as Surface Acoustic Wave (SAW), electro-wetting-on-dielectric (EWOD) and dielectrophoresis. To date little only limited research has been made on the integration of these technologies together into an efficient lab-on-chip platform. This work looks at the development and characterisation of SAW devices utilising MEMS fabrication techniques and using the Avidin-Biotin system for biosensing.

Bin Xu
Smart materials for Bio-MEMS application
Smart materials provoked a research fever as their responsive behavior to outer stimulations, some of which had been successfully applied, such like bio-medical devices based on shape memory alloy (SMAs). Shape memory polymers (SMPs) offer a much higher degree of deformation and a wider scope of mechanical properties than SMAs, in addition to their inherent advantages of cheapness, biocompatibility, light weight, and easy processing. Attempts have made with shape memory PU nanocomposites as shown on previous publication. A compulsively investigation on polystyrene-based nanocomposites will be presented in this work, including the micro-engineering and primary bio-testing, with expecting to explore the advanced smart materials, potential applications and micro-fabrication techniques.

Yufei Liu

Integrated Sensors for Condition Monitoring Application

This aim of the project was to develop novel miniature sensors and integration technology for health/condition monitoring in microsystems. The project has carried out design, fabrication and testing of miniature sensors based on microfabrication technology, processes and methods for sensor integration. Platinum based meander sensors of minimum track width of 3μm have been produced resulting in a footprint of only 250μm×240μm. The miniature temperature sensors have also been successfully applied to process monitoring in laser assisted polymer bonding technology for MEMS packaging. SAW based humidity sensors have been fabricated and characterised. In order to realise integrated sensors temperature and SAW sensors have been fabricated $LiNbO_3$ substrates. Integration of a MEMS pressure sensor on the same substrate is being carried out to achieve a sensor chip for simultaneous monitoring of temperature, humidity and pressure.