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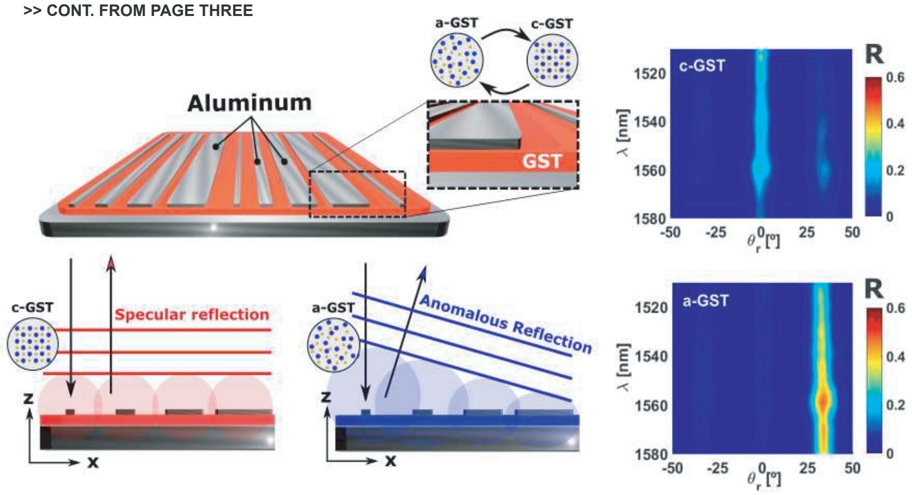


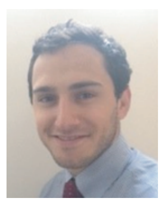
de Galarreta et al. have demonstrated a novel phase change material based metasurface for wavefront shaping in the infrared region. They exploited hybrid dielectic/plasmonic resonances to achieve local (subwavelength) phase control of light with low losses. High absolute efficiencies up to 65% were achieved; significantly higher than the efficiencies of more commonly reported plasmonic-based phase-change metasurfaces.

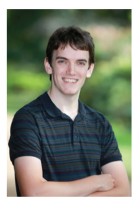
DOI: 10.1109/ISCAS.2018.8351784

Phase change beam steering device and working principle

Employee Updates

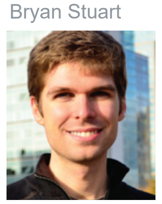
Welcome & Farewells


Bryan Stuart


Ben Porter


Krish Murugappan


Vincent Tobin


Nathan Youngblood


Ghazi Sarwat

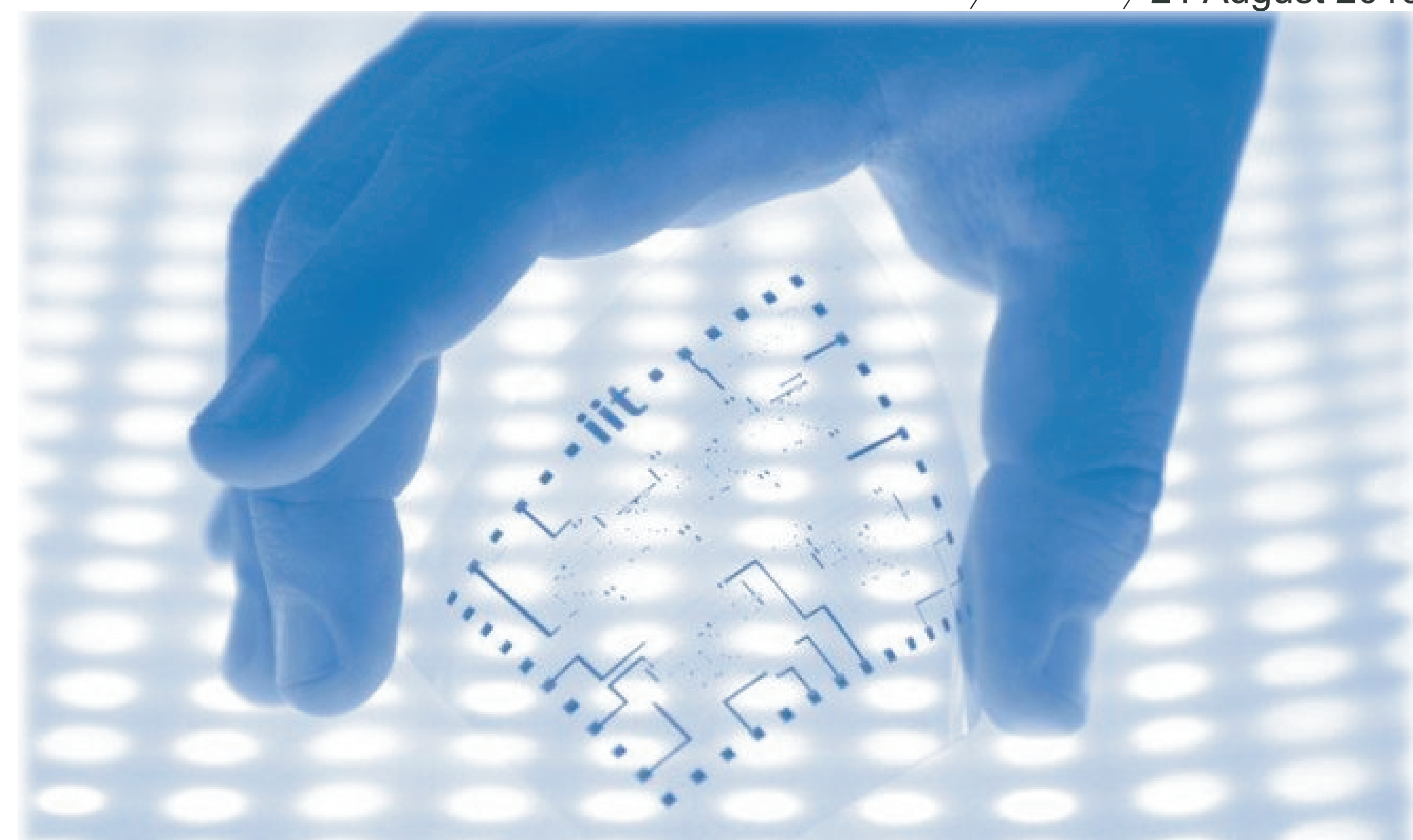
We said farewell to Dr. Bryan Stuart, who had headed up the activity in in-line roll-to-roll patterned deposition in Hazel Assender's group. Bryan has moved onto a leading vacuum deposition activity in industry. We also bid farewell to Dr. Benjamin Porter and Dr. Krishnan Murugappan who both worked on wearable fiber sensors. Dr. Ghazi Sarwat has joined a collaborator in IBM, Zurich. Dr. Nathan Youngblood is now an Assistant Professor at the University of Pittsburgh.

We are pleased to welcome Dr. Vincent Tobin, returning to Oxford after a few years working in industry to take on this role. Vincent did his DPhil in Hazel Assender's group in Oxford on roll-to-roll processed ultra-high gas barrier layers.

Recent Events

WAFT annual collaboration meeting Collaborators get together to share cutting edge research and ideas.

21 August 2019



Welcome to the 2019 WAFT meeting. WAFT aims to accelerate the development of wearable and flexible technologies by integrating device components using advanced functional materials along with scalable, cost-effective and reliable manufacturing techniques.Through the years, we have developed scalable roll-to-roll technologies suitable for cost-effective deposition of functional phase-change, photovoltaic, organic sensor and thermoelectric materials. We also develop new approaches for effective in-situ monitoring of key film parameters to guarantee designed-for functional material properties at the manufacturing stage.

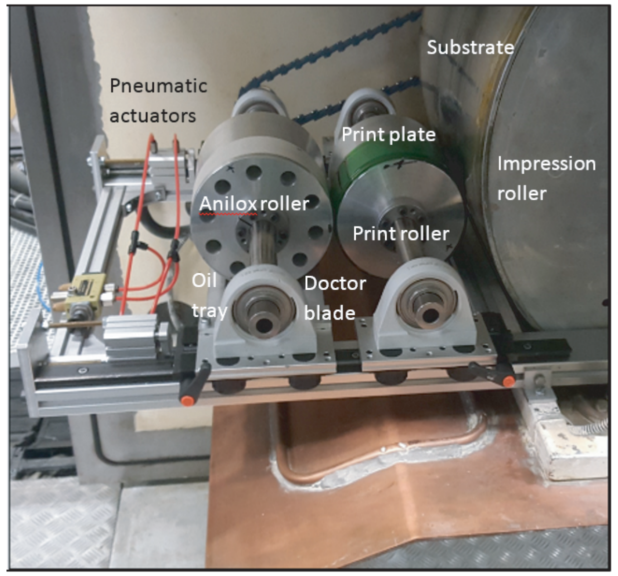
This newsletter showcases the research highlights and publications for 2018 and 2019.

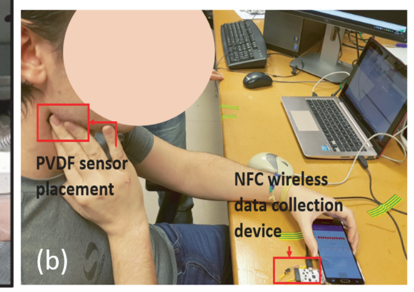
> “I think everyone is frustrated at having had technology demonstrated in a lab so long ago and not being able to manufacture it”

Research Highlights

Roll-to-Roll Patterning

Bryan Stuart has designed, built and installed a new flexoprinting capability in the Oxford webcoater (see picture). This has allowed us to print patterns of metal, or other materials, by either evaporation or sputtering by a roll-to-roll process with webspeeds (print substrate speed) currently up to 25 m/min. We are working across a number of activities in the WAFT collaboration including in the areas of OTFTs (Oxford Materials and Engineering), thermoelectrics (Oxford Materials and Southampton) and sensors (Oxford materials: Assender & Castell groups) to exploit and test this capability in a range of applications. A collaboration between WAFT activities in Oxford Materials and Engineering Science has allowed





the circuit design, manufacture and testing of very low cost amplification circuits using all flexible materials (metals and organics). These circuits are being applied in a range of sensors suitable for health monitoring with a low cost, flexible 'patch' that can be applied to the skin. In collaboration with researchers at Imperial College London, we have carried out successful trials of a low-power pulse monitor, capable of outputting an ECG signal via a mobile phone interface. The work has recently been published in: K. Zhang, C.-M. Chen, S. Anastasova, B. Gil, B. Lo, H. Assender "Roll-to-roll processable OTFT-based amplifiers and application for pH sensing" 2019 IEEE 16th International Conference on Wearable and Implantable Body sensor networks. DOI: 10.1109/BSN.2019.8771092

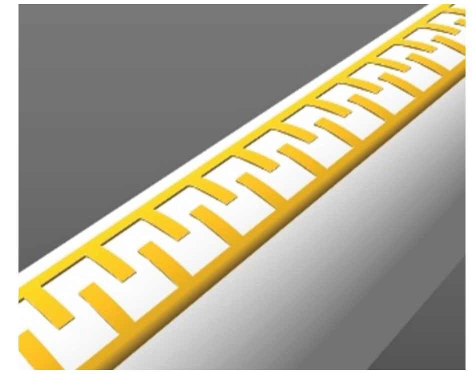
Conferences Attended

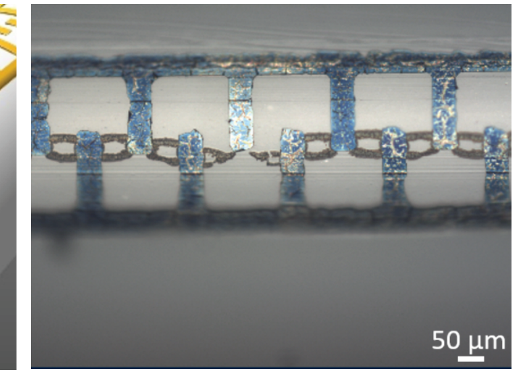
▶ AVS 65th Symposium, Long Beach California: Oral presentation
- Kai Zhang: Roll-to-Roll processable OTFT sensors and amplifier
- Bryan Stuart: Flexography oil patterning for inline metallization of aluminium electrodes onto polymer webs

▶ P70 Polymer Engineering International/UK-China AMRI conference, Bradford: Oral presentation
- Hazel Assender: Roll-to-roll processing for flexible devices

▶ Plasma surfaces and thin films, London: Invited oral presentation and poster
- Hazel Assender: Deposition and applications of plasma-cured vacuum-deposited acrylate coatings
- Xudong Tao: Investigating the manufacturability of flexible thin-film devices (TEGs) using roll-to-roll processing

▶ SCI Functional Surfaces meeting: Oral presentation
- Merel Lefferts: Percolation networks of conductive polymers for on the go vapour sensing



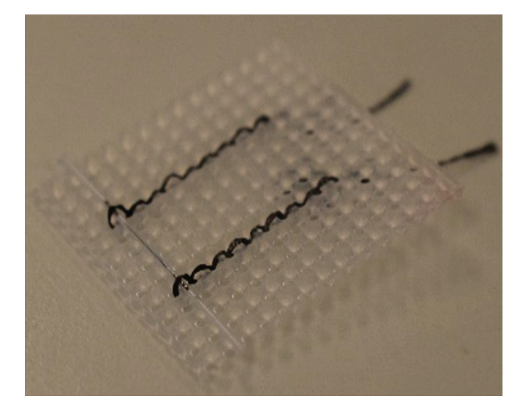


Design of a gas sensor on a fiber for a truly flexible and wearable device that blends almost seamlessly with our clothing.

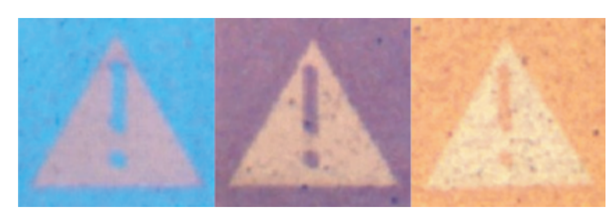
Porter et al. used modern microfabrication methods and in-situ electropolymerisation methods to build a gas sensor directly onto the surface of polyester fibres.

Interlocking electrodes were deposited directly onto the surface of a 500 µm diameter PET fibre. Once fibres were coated with these electrodes, they were sewn into PET substrates using Ag-coated conductive thread, providing a connection. Once mounted, these fibres can be electropolymerised with polypyrrole (PPy), which connect the two electrodes and make them sensitive to absorption of ammonia (NH_3) gas.

The fibers show a clear and robust electrical response with exposures to ammonia as low as 700 ppb. The fiber can be sewn directly into textile fabrics.



A photo of the fiber sensor sewn into a PET fabric



Warning signal rendered using a scanning laser to crystallise selected parts of the device turning them cyan, magenta or yellow.

Carrillo et al. have combined ideas in phase-change optical metamaterials/metasurfaces, and optoelectronic displays to deliver a novel switchable phase-change metamaterial/metasurface resonant absorber having nonvolatile color generating capabilities. They are able to generate vivid cyan, magenta and yellow pixels by selectively tuning the resonant absorber. DOI: 10.1002/adom.201801782

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Recent Publications Highlights

Carrillo SGC, Trimby L, Au YY, Nagareddy VK, Rodriguez-Hernandez G, Hosseini P, Rios C, Bhaskaran H, Wright CD. (2019) A Nonvolatile Phase-Change Metamaterial Color Display, Advanced Optical Materials, DOI:10.1002/adom.201801782

Feldmann J, Youngblood N, Wright CD, Bhaskaran H, Pernice WHP. (2019) All-optical spiking neurosynaptic networks with self-learning capabilities, Nature, volume 569, pages 208-214, DOI:10.1038/s41586-019-1157-8.

Rios C, Youngblood N, Cheng Z, Le Gallo M, Pernice WHP, Wright CD, Sebastian A, Bhaskaran H. (2019) In-memory computing on a photonic platform, Sci Adv, volume 5, no. 2, DOI:10.1126/sciadv.aau5759.

Li X, Youngblood N, Ríos C, Cheng Z, Wright CD, Pernice WH, Bhaskaran H. (2019) Fast and reliable storage using a 5 bit, nonvolatile photonic memory cell, Optica, volume 6, no. 1, pages 1-6, DOI:10.1364/OPTICA.6.000001.

Nagareddy VK, Octon TJ, Townsend NJ, Russo S, Craciun MF, Wright CD. (2018) Humidity - Controlled Ultralow Power Layer - by - Layer Thinning, Nanopatterning and Bandgap Engineering of MoTe2, Advanced Functional Materials, volume 28, article no. 1804434, DOI:10.1002/adfm.201804434.

Von Keitz J, Feldmann J, Gruhler N, Ríos C, Wright CD, Bhaskaran H, Pernice WHP. (2018) Reconfigurable Nanophotonic Cavities with Nonvolatile Response, ACS Photonics, volume 5, no. 11, pages 4644-4649, DOI:10.1021/acsphotonics.8b01127.