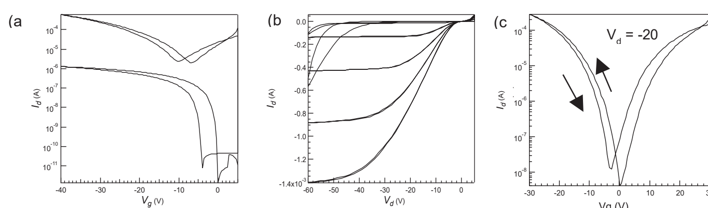
commodity polymer will moreover allow fine-tuning of the mechanical properties, a feature that can be of great importance in the printing electronic area, assisting the deposition of more stable active layers.



Representative transfer (a) and output (b) characteristics of DPP-T-TT:HDPE 60:40 bottom-gate bottom-contact field-effect transistors. Source-drain voltages are -1V and -40V. Source-gate voltages in the outputs ranges from 0 V to -40 V with -10 V step. Ambipolar transfer characteristics (c), source-drain voltage is -20V.

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BIOGRAPHY

2013 - Bachelor in Science and Materials Engineering (University Federico II Naples ITA)

2015 – Master degree in Materials Engineering and Nanotechnology (Politecnico di Milano ITA)

2016 on – PhD student in Natalie Stingelin's group (Imperial College London) as an Early Stage Researcher in INFORM - Marie Sklodowska-Curie Innovative Training Network

19: Interconnection Technologies for Integration of Active Devices with Printed Plastic Electronics

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ABSTRACT

Printed electronic circuits on low-temperature plastic substrates have enormous potential across a range of consumer markets including automotive windows, wearable devices, healthcare devices and smart labels. Many of these applications require a combination of both printed electronics, which offers large area and flexibility at low cost, and conventional silicon electronics which allows much greater functionality. Currently the main technique used for integrating silicon devices with plastic electronics is Isotropic Conductive Adhesive (ICA) packaging. With this approach, a conductive adhesive (typically a silver-loaded paste) is printed onto the substrate at sites where electrical connection is required. The silicon device is then placed in position, and the adhesive is cured. The same approach is also being used to mount flexible plastic electronic chips on plastic substrates. In this project we will investigate the use of Non Conductive Adhesive (NCA) packaging as an alternative route for integrating active devices on low-temperature substrates. With the NCA approach, electrical connections are mediated by conductive bumps on the active device, and the role of the adhesive is purely to pull these bumps into contact with the pads on the substrate. NCA packaging offers several advantages over ICA. Firstly it is more efficient at the point of assembly because it does not require selective deposition of the adhesive; instead the NCA is dispensed (or applied in film form) over the entire device area. Secondly, it inherently provides an underfill between device and substrate which improves reliability; thirdly it is scalable to finer interconnect pitches which will become important in the future. In addition to working on pure NCA packaging, we will also explore the feasibility of using thermosonic (TS) bonding to form metal-metal

micro-joints between the bumps and the substrate pads. TS bonding uses a combination of heat, pressure and ultrasonic energy to facilitate the formation of direct metal-metal bonds at lower temperatures and pressures than would be required for thermo-compression bonding. If a working process can be established for plastic electronics then it will provide more reliable interconnections than any purely adhesive-based approach.

Ultimately we envisage a combined thermosonic-adhesive (TA) process for plastic electronics in which a thermosonic bonding step is carried out during the NCA curing cycle – see Figure 1. The process comprises four steps: (1) apply NCA to plastic electronic substrate; (2) place and align active device; (3) apply pressure, heat and ultrasound as required to form TS bonds and cure NCA; (4) cool and withdraw pick-up tool.

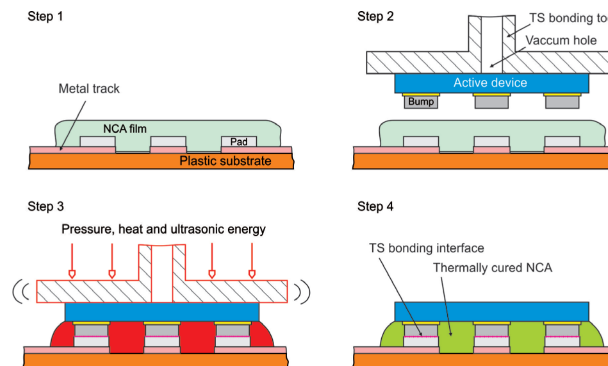

Figure 1. Thermosonic-adhesive packaging process combining NCA packaging and thermosonic bonding

BIOGRAPHIES

Dr Guangbin Dou is a Research Associate in the Department of Electrical & Electronic Engineering at Imperial College London. Dr Dou has a PhD in Electronics Manufacturing, with 9 years research experience in microsystems devices and microelectronics manufacturing. He has more than 25 high-quality publications, including journal papers published in Advanced Materials, Applied Physics Letters and CrystEngComm. He has delivered keynote speeches and invited talks on several occasions at international conferences and research institutions, and he has received an IEEE Outstanding Conference Paper award. Moreover, he has been awarded 2 patents, with one commercialised. He was a key researcher on the NASA InSight Mission to Mars where he was part of the team that has built the most accurate and reliable seismometers to date; these devices will be sent to Mars in 2018. Working on a NASA funded project has given him valuable experience in working to a strict project schedule, as well as knowledge of their reporting and logging to standards.

Professor Andrew S Holmes is Professor of Microelectromechanical Systems (MEMS) in the Department of Electrical & Electronic Engineering at Imperial College London. Professor Holmes has worked extensively on MEMS devices and fabrication technologies, and also on micro-assembly technologies for MEMS and electronics manufacturing. He has published around 150 journal and conference papers in these areas, including a number of invited papers at international conferences. He is a founding member of the Technical Coordination Committee on MEMS within the Industrial Electronics Society of the IEEE, and an Associate Editor of the IEEE Journal of Microelectromechanical Systems. He is also a co-founder and director of Microsaic Systems plc, an Imperial College spin-out company started in 2001 to exploit Imperial College MEMS research. The company, which has developed a bench-top mass spectrometer based on MEMS technology, was admitted to AIM in 2011.