# MIT Visit Report:
# Daniel Ashall - Summer 2011

As part of his postgraduate studies at Bangor University PhD Student Dan Ashall was given the opportunity to spend 10 weeks of the summer working within a research group at Massachusetts Institute of Technology (MIT). MIT is located in Cambridge on the east coast of the USA. Dan's hosts were the Soft Semiconductor Group whose main focus regards the optoelectronic properties of organic materials and their utilisation. This work compliments that of Bangor's research group, the Plastic Electronics Research Centre which is based within the School of Electronic Engineering, and was a fantastic chance to both employ and develop knowledge and skills at a world leading establishment. The placement was fully-funded by the **Drapers Livery Company**, trustees of the legacy of Prof. M Wynne Davies. Further generosity on their behalf also enabled Dr Jeff Kettle, a member of faculty, to join Dan at MIT for a period of time working on a separate project.

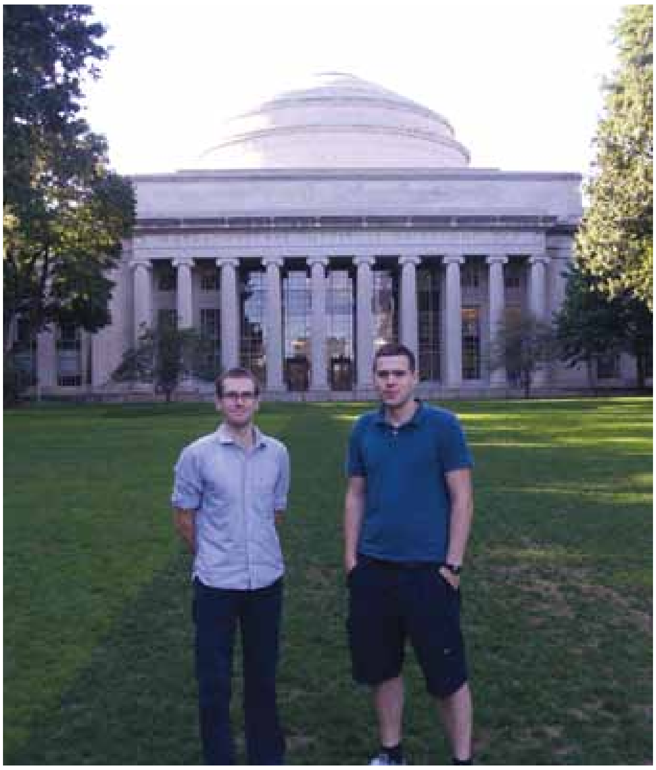

*Figure 1: Dan Ashall and Dr Jeff Kettle (left) in front of the MIT dome*

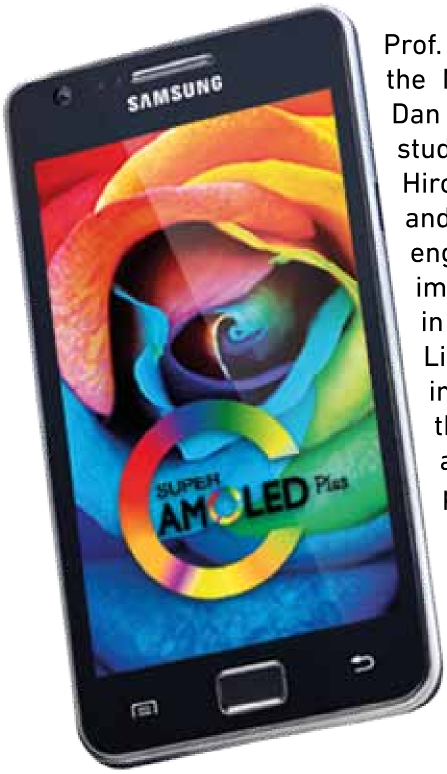


*Figure 2: Samsung's Galaxy S smart phone with its Active Matrix OLED display (3).*

Prof. Marc Baldo, who heads the MIT group, arranged for Dan to work with two of his students, Matthias Bahlke and Hiroshi Mendoza. Matthias and Hiroshi were already engaged in the project to improve the processes used in the fabrication of Organic Light Emitting Diode (OLED) information displays (1), the type that are used in a number of consumer products such as televisions (2) and smart phones (3) similar to the one shown in figure 2. OLED displays have a number of advantages over competing technologies such as those based on Liquid Crystals (LCDs). Higher power efficiency, better colour reproduction and an enhanced field-of-view are frequently cited examples (3) (4) and according to DisplaySearch the technology is expected to see a threefold market increase reaching $14 billion by 2015 as quoted in (5).

Recently, Samsung, the industry leader, has invested heavily in Active Matrix OLED displays opening a 5.5th-generation production plant with the capacity to manufacture full size high definition televisions (HDTVs) (5). Generation is directly linked to the size of the mother glass and in theory manufacturing costs are significantly reduced and output is similarly increased through scaling-up (1). At present the commercial manufacture of OLED displays is achieved in a vacuum environment via a thermal process. Metals and organic small-molecules are evaporated to form the classic OLED structure for each subpixel on the display. For a 32" full colour HDTV, two million pixels composed of red, green and blue subpixels must be reliably produced on the mother glass. A subpixel here is approximately 370 x 120 µm in size (1); the latter dimension is similar to the width of a human hair (6).

The patterning of each pixel has been problematic since the inception of the OLED displays as the photolithographic techniques used in the conventional semiconductor industry are generally not compatible with organic materials and instead a masking type process is employed (4). These masks are not ideal – they are expensive to produce ($200,000), must be regularly cleaned and are easily damaged requiring replacement every couple of months (1). With this current strategy, patterning becomes inherently problematic as the generation increases and this may be a major block to realising full commercial potential from the technology.

The work on a new patterning method relied on the phase change of inert CO2 at different temperatures and pressures. The outcome of this study for which Dan is a co-author is due to be presented at a conference in South Korea later this year (7). The process which takes place entirely within a vacuum deposition chamber is fully described in the aforementioned report. Following this successful proof of principle, it was reasoned that a dedicated system was required to enable more experimentation time and greater control of the sensitive equipment between tests. In order to facilitate this the team were tasked with designing and procuring the new equipment - a customised glovebox system was purchased and arranged such as to integrate with a custom vacuum chamber which Dan helped to design. The CAD model of this system is shown in figure 3.

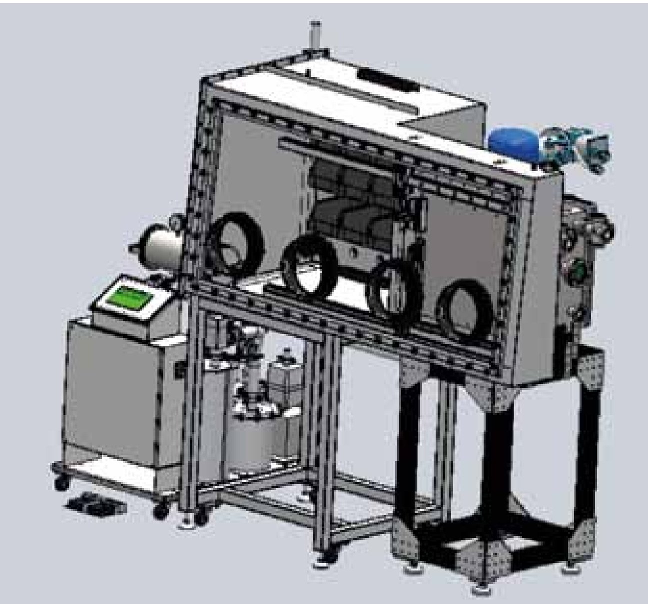

*Figure 3: LC tech glovebox with our in-house integrated vacuum chamber designed to further develop the project.*

Dan said of his experience: "My time in the USA also gave me an opportunity to meet and work with a variety people at the forefront of their science both at MIT and the neighbouring Harvard University. On a social front, I joined my new colleagues on rock climbing trips in the White Mountains and learned to sail on the Charles River. I feel that I have strengthened the links between our universities as a result of this trip." Dan went on to say: "My thanks go to the Drapers Livery Company and the generosity of the legacy of Prof. M Wynne Davies who have facilitated this visit. I would also like to express my appreciation to Prof. Martin Taylor for the arrangements that he made and also to Prof. Marc Baldo for kindly agreeing to be my host. Finally I wish the best of luck to my colleagues Matthias and Hiroshi in their future careers."

## Bibliography

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