Plastic Electronics

House of Commons Committee on Innovation, Universities and Skills

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0.0 The following response has been produced in consultation with Fellows of The Royal Academy of Engineering and their associates with expertise in the area of plastic electronics. Plastic electronics technology offers new opportunities in the development of displays, sensors, printed batteries, photovoltaics, lighting and signage and organic tags and labels. The main thrust of the response is that plastic electronics constitutes a great opportunity for UK industry and engineering. This is an opportunity that can be grasped or lost. The UK Government needs to take decisive action to support the development of this industry in the UK, from research to manufacture. This is an area where the Government needs to create a strategy to ensure that plastic electronics can develop into a thriving UK industry. This strategy should ensure that funding is available and that action can be taken swiftly when opportunities arise to begin manufacture in the UK.

1) The current and future roles of engineers in the field of plastic electronics

1.1 If the UK is to develop a plastic electronics industry then engineers will be central to this field. Hence, as the field grows, there will be an increasing number of roles and opportunities for engineers. It is key that the UK has the right engineers to fill these roles, and currently the UK does have many of the requisite engineering skills. Electronics exploits skill sets that exist in the UK but which have been underexploited since the ‘80s. These skill sets are semiconductor electronics and materials science combined, and process engineering. The growth of the plastic electronics industry in the UK would present significant opportunities for these engineers.

1.2 It is important to note that currently there are two methods being developed and used for manufacturing plastic electronics. One is based on the method of deposition and removal of material that is used in the manufacture of silicon electronics. The other is a novel method of printing electronics. The comments under the points below might differ with respect to which of these methods is being considered.

<u>Research</u>

1.3 The field of printed plastic electronics began very much upstream in the university sector. Many of the breakthroughs in the development of printed electronics are a product of the work of researchers from the Cavendish laboratory at the University of Cambridge. There are other strong research groups in plastic electronics in the universities of Oxford, St Andrews, Durham, Manchester and Sheffield and Imperial College London.

1.4 There are considerable further research opportunities for engineers in the UK. For example, several UK research groups including the Cavendish Laboratories are pursuing early stage research in using plastic electronics to produce cheap solar cells. This and other possible developments in the plastic electronics field mean that there will continue to be future roles for engineers in research.

1.5 However, it is important to keep a broad definition of ‘engineer’ in mind here. A lot of the research in this area began in physics rather than engineering departments. But this is a reflection of the fact that physics departments in the UK are heavily involved in applied science (the Cavendish laboratory in particular). This contrasts with, for example, the US, where work of this nature would certainly be in an engineering department, most likely such as materials science and engineering. Hence, it is important not to draw to sharp a distinction between UK engineers and physicists when considering the plastic electronics sector (or other sectors, for that matter).

Development

1.6 The UK has had great success in developing plastic electronics to bring them to the point of manufacture. The companies Plastic Logic and Cambridge Display Technologies are spin outs from the University of Cambridge and have been enormously successful in bringing printed electronics to the point of manufacture. Dupont Teijin films based in the north east has also done valuable work in the area of 'planarization' – the smoothing out of films so that they can be used as a substrate for printed electronics. The Plastic Electronics Technology Centre (PETeC) has been recently established in the North East to assist in prototyping and promoting commercialisation.

Manufacture

1.7 Phillips and its spin-out Polymer Vision developed methods for producing plastic electronics based on traditional processes for manufacturing silicon semiconductors, by means of deposition and removal of material rather than printing. The company Innos, a spin-out of the University of Southampton, won the contract to manufacture plastic electronics in this way. Innos had set up a fabrication facility with a state-of-the-art cleanroom, using fabrication facilities previously used for producing silicon semiconductors. This was attractive to Polymer Vision as the high specification cleanroom would allow manufacturing in higher quantities. This allowed Polymer Vision to continue development of plastic electronics to bring them closer to the point of manufacture, focusing on yield improvement and finalization of the product. Innos has now been bought out by Polymer Vision but the manufacturing facility remains in Southampton.

1.8 The traditional methods of manufacturing used by Polymer Vision meant that use could be made of existing plants which produced silicon semi-conductors and the expertise which came with them. It takes little work to develop these in order to produce plastic electronics by the same methods; therefore there is some room for manufacturing to grow in the UK in this area.

1.9 In the realm of printed electronics, the UK has been successful in the first phase of taking science and early stage engineering to the point of manufacturability. However, Plastic Logic is now entering the manufacturing stage, but will be basing its manufacturing overseas in Dresden. There are a number of reasons for this. First, there is a workforce with relevant experience in Dresden, as demonstrated by the success of the large process facility operated by AMD there, whereas it is unclear what companies Plastic Logic would recruit from to get manufacturing staff in the UK, with the diminishing semiconductor volume manufacturing base. Second, it was possible to move very swiftly in the process of setting up a plant (a point which will be returned to below).

1.10 In the case of both Plastic Logic and Polymer Vision there have had to be collaborations with overseas companies for financial support and manufacturing. Although such collaboration brings benefits, it does mean fewer roles for UK engineers in product development and manufacturing. While these firms are based in continental Europe they are only providing limited employment opportunities for UK engineers (though the fabrication facilities in Southampton set up by Innos and now run by Polymer Vision provides employment for some UK engineers). The UK produces many skilled process engineers who are employed across the globe and it would be of great value to develop opportunities for them to be employed in the UK, contributing to the UK economy.

2) The potential for plastic electronics in the UK/global economy

2.1 Plastic electronics have the potential to transform the UK and global economy tremendously, having as big an impact as the development of silicon. At this point plastic electronics is not a mass technology but is still 'waiting to happen'. However, performance has now been demonstrated showing that its potential is very strong. This means that we are now on the brink of a sea-change in how electronic devices/products are marketed. Plastic Logic's electronic paper is moving closer to market with US investors currently placing bets on this. There is strong international interest in this technology and manufacturing interest in Asia is gathering pace.

2.2 Plastic electronics have the capacity to transform electronics generally. If printed circuits come to maturity it would be possible print circuits straight from a computer. This would have a profound impact on prototyping, making it significantly easier. Normally UK start-ups have to manufacture overseas, but this would allow easy small-scale manufacture of prototypes. This could change the paradigm of electronics manufacturing, having smaller production lines instead of large manufacturing centres based overseas. It could potentially see the return of high-tech manufacturing to the UK.

2.3 There is certainly the potential for some degree of change to the current manufacturing paradigm. Although capital for manufacture in this area is substantial, it amounts to hundreds of millions rather than billions. The logic which forced silicon manufacture to be focused in small areas does not apply in this area, hence there is potential for manufacture in Europe – producing value chains in design, manufacture and marketing.

2.4 The development of plastic electronics will also facilitate the growth of pervasive electronics. It provides opportunities to develop products that use plastic electronics – consumer products including devices that you can wear. There is great potential in the UK to establish companies based on the end products that use plastic electronics.

2.5 The UK is in the lead in this area – ahead of the US. It could lose this lead if opportunities are not grabbed, in which case the potential for plastic electronics to boost the UK economy would be lost.

3) How universities, industry, venture capital and Government are involved in the development of the UK plastic electronics sector

<u>Universities</u>

3.1 The role of universities has already been described – though it is important to look beyond engineering departments in universities. As explained, physics departments in the UK have greater involvement than they might in the US due to their focus on applicable research.

3.3 Universities have so far been very successful in setting up spin out companies to develop this area. This should be encouraged to continue – perhaps in particular setting up a company to develop solar cells based on plastic electronics.

3.2 At the moment the area is well serviced by students, mainly from physics and chemistry. However, it would be beneficial to set up specialized teaching courses in this area to serve the industry as it grows. The University of Southampton is currently training PhD students in this area.

Industry

3.4 Traditional industry tends to be risk averse therefore relying on existing players in industry to develop plastic electronics would mean that little headway will be made in these new areas. However, Merck, which has based its R&D activities in this area in Southampton, is an exception to this.

Venture capital

3.5 Venture capital has a major role to play in developing the plastic electronics sector. USD120m of venture capital was raised to set up Plastic Logic's manufacturing facility, a very significant investment.

3.6 Venture capitalists will invest large amounts of money when an industry is becoming established, but not when it is still at the research stage. Venture capitalists cannot invest in an area unless there is an exit in the next 3-7 years. Government often tends to support the early research stage, but sometimes with not enough finance to get a company from start-up to the state where venture capital will become involved. This is an area where it would be helpful for Government to work with venture capital funding to support the development of plastic electronics from research through development to manufacturing. If the gap persists, then more companies will have to go overseas and the opportunity for the UK will be lost.

3.7 University venture funds can be of great benefit– eg, Cambridge Challenge Fund[1], Imperial Innovations and similar at Oxford. However, there is still need for strategies to fund research through development to manufacture.

Government

3.8 An important role of the Government is to create the right environment for venture capital to make investments – in terms of the right tax environment and supporting the development of the UK skills base. Government funding also plays its part, through what were the DTI schemes and the European Framework. However, such funding is rarely a catalyst for new work, and tends only to fund already likely to be taken up. UK Government funding contrasts with Darpa funding in the US which seems to constitute a swifter, less bureaucratic system which is more effective in supporting novel research.

3.9 Generous and swiftly available Government support paved the way for Plastic Logic to set up its manufacturing base in Dresden. Dresden is, like Wales, a development area and therefore there was local support for a plant there. When setting up a plant (especially in a Greenfield site) the time lapse between agreement and finishing the plant is critical; in Dresden, only 15 months after the money being handed over the factory is almost ready to go. One North East supported the development of PETeC in County Durham, but this project has moved ahead far less swiftly. If it is felt that the UK should try to develop manufacturing strengths in plastic electronics then the UK Government and the RDAs need to consider how they can make decisive and swift funding decisions, to support the swift build of facilities, to attract manufacture within the UK.

[1] Though it is important to note that this fund was *not* used by Cambridge Display Technologies or Plastic Logic.

4) Are the UK engineering and manufacturing sectors set up to handle growth in this area or other areas like it?

4.1 In terms of the traditional methods of producing semiconductors adapted for plastic electronics, there is the capacity for manufacturing in the UK. Hence the only real manufacturing currently done is by Polymer Vision at Southampton, using a site which was home to the oldest fabrication facility in the UK (though all of the equipment presently used there is new). There are other disused 'fabs' that have the facilities, the equipment and the knowledge to allow fabrication here. These should be exploited to a greater extent.

4.2 However, in terms of printed electronics there is not currently the capacity to manufacture in the UK. Large-scale manufacture of products is likely to continue to be based overseas but there is potentially a role in the UK for the development of small specialized devices where design is important. In principle, however, plastic electronics presents an opportunity to change manufacturing paradigms, bringing manufacture back to the UK. The committee may find it useful to explore the possibility and likelihood of such a change.

4.3 In order for growth in this area it is vital that the UK has the requisite human capital. The UK has started to attract skilled people in this area and it needs to continue tempting people from overseas as well as fostering UK engineers. It must also retain its best students who have come into the UK university system from around the world. It also needs to invest in the training of skilled clean room technicians, which are a scarce resource in the UK, but essential for the manufacturing of plastic electronics.

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