Organic evolution

Belgian research institute imec is uniquely capable of manufacturing both polymer and small-molecule organic photovoltaic technology. **Nadya Anscombe** talks to Tom Aernouts, team leader of the organic photovoltaic division at imec, about these competing technologies.

■ What are the main differences between polymer and small-molecule organic photovoltaic technologies?

The main distinction between the two is their manufacturing techniques. Polymer materials can be solution-processed, whereas small-molecule materials are generally vacuum-deposited. The manufacturing technology that uses solution-processing is closer to market and is suitable for large-scale, rapid production. In fact, US firm Konarka has already launched several products using roll-to-roll printing techniques. German company Heliatek is also having considerable success in the development of high-throughput vacuum processing technology for manufacturing organic photovoltaic (OPV) cells.

■ Which technology is winning the race?

At the moment both technologies have similar performance characteristics, with efficiencies of around 6–8%. Although solution processing is the simpler of the two manufacturing methods, the choice of materials that can be processed in solution is restricted. A greater number of materials, particularly electrode materials, can be vacuum-processed. Furthermore, vacuum deposition achieves a higher material purity than solution processing, and also allows the structural control in device configurations — gradient or doping profiles — to be explored more broadly. Advanced configurations such as multijunction cells (multiple cells stacked on top of each other, each designed to absorb light in a different wavelength band) may be needed to improve the efficiencies of OPV cells, and vacuum deposition has already proved to be more successful than solution processing for these complicated configurations. In the organic LED industry, people initially thought that high-throughput polymer processing would be the winning technique, but today most of the organic LED devices on the market are based on small-molecule technology. Whether the same thing will happen to the OPV industry is debateable. The cost structures for the two techniques are very different; the investment costs for vacuum deposition are greater, but these are offset by the wider availability of materials with better efficiencies and longer

Tom Aernouts: “Our aim is to demonstrate innovative cell concepts with efficiencies of 10% by 2012.”

lifetimes. Solution processing can produce large quantities of cells, but these have lower efficiencies than those produced through vacuum deposition. As to which will ‘win the race’, the industry is undecided, and so are we at imec. This is why we are still investigating both technologies. The answer may even be a combination of the two — some layers could be printed, for example, while others could be vacuum-deposited.

■ How can OPV technology compete with silicon solar cells?

OPV technology does not need to compete with silicon technology, as it can be aimed at entirely different markets. OPV technology does, however, have two major advantages over silicon technology: OPV cells can be made in many shapes and sizes, whereas the sizes of silicon solar cells are standardized, and OPV technology works with indirect illumination, whereas the efficiency of silicon solar cells decreases dramatically when the light is not directly incident or decreases in intensity. The angle of incidence does not play a big role in OPV technology, meaning that OPV cells can, for example, be hung vertically on walls or be integrated into windows.

■ What applications do you foresee for OPV technology?

The design flexibility of OPV technology

gives almost endless possibilities. Some companies have already launched products such as rucksacks integrated with solar cells for charging mobile phones, solar-cell curtains or semi-transparent windows that function as solar panels. We at imec have also tried to come up with new and unusual applications. Because OPV cells can be made on a flexible substrate, we have designed a bracelet that can alert the wearer through vibrations when the internal sensor detects a particular signal. This could, for example, be used to warn someone with a heart problem about any irregularities in their heart rate.

We have also investigated the integration of solar cells in packaging, for example as replacements to holograms or for lighting up a logo. Such technology would be even more difficult to copy than a hologram and could help to prevent counterfeiting. Imec is also involved in Flexible Autonomous Cost Efficient Energy Source and Storage, a European programme that aims to integrate OPV technology with printed electronics and thin-film battery technology to develop a flexible, fully autonomous energy source. Such a technology could be useful in wireless sensor networks.

■ What does the future hold for OPV technology?

We have seen dramatic improvements in efficiencies and lifetimes over the past few years, and these will keep improving. Our aim is to demonstrate innovative cell concepts with efficiencies of 10% by 2012. Furthermore, the scalability of these concepts will be demonstrated by devices of 15 cm × 15 cm using high-throughput, linear deposition techniques that are industrially relevant, instead of typical laboratory techniques such as spin coating. Furthermore, our in-house technology allows us to stabilize the active layer, leading to a tenfold improvement in device lifetime. In combination with the right encapsulation technology, we believe we can achieve operational lifetimes of over ten years.

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