A ray of sunshine for UK solar energy
SPECIFIC

Introduction

Based in Baglan Bay, South Wales, SPECIFIC is an Innovation and Knowledge Centre (IKC), led by Swansea University with Tata Steel, BASF and NSG Pilkington as the main industrial partners. SPECIFIC aims to develop functional products that will transform the roofs and walls of buildings into surfaces that will generate, store and release renewable energy.

The centre encompasses the development laboratories for the technologies being developed as well as pilot production lines that enable the demonstration of full scale manufacture of 1.2m^2 sheet steel, glass and polymer substrate based products as well as a coil line for continuous processing of flexible (steel and polymer) materials up to 300mm in width.

Background

Energy security has been highlighted to be one of the biggest challenges facing the world as demand for power accelerates at a time when we are striving to decouple from the fossil fuel based energy infrastructures that underpin the global economy. With current state of the art technology mainly being based upon heavily subsidised overseas manufactured silicon / glass technology there has been a drive to move to more flexible substrates. However many of the thin film technologies rely on active materials such as cadmium telluride (CdTe) and copper indium gallium selenide (CIGSe). According to the 2011 British Geological survey data for mine production, tellurium, indium and gallium are extracted at a rate of 96, 641 and 216 metric tonnes (MT) per year. Conservative estimates suggest that even doubling the supply rate of these elements by 2026, the penetration of these technologies will peak at 30% (CdTe) and 10% (CIGS) respectively. At this point in time, thin-film manufacturing capacity will experience a steep decline due to depletion of reserves. Also the materials used currently pose significant challenges in terms of toxicity both in service and at the end of life. Therefore there is an imperative to look to technologies that are based upon more environmentally friendly and stable Earth-abundant resources.

Opportunity

- To reduce and eliminate the need for the Critical Raw Materials (CRM) in next generation photovoltaics (PV)
- To develop low cost manufacturing, with ambient processing techniques
- Increase the efficiency of PV technology
- Increase the availability of cost competitive flexible PV
- Increased design flexibility with new flexible substrates

Approach

- Development of hybrid organic-inorganic solar cell technology
- Delivering a printable solid state technology
- Developing technology based on Earth-abundant materials
- Developing scalable technologies for both glass and flexible (plastic & metal) substrates
- Increase the conversion efficiency of the CRM free PVs

Impact

- Reduced cost of photovoltaic cells
- Increased sustainability and end of life recyclability of the photovoltaic technology
- Significantly reduced CRM dependence for required increase in production volumes
- Reduced toxicity and chemical complexity embedded in the devices
- Contributing towards a multi-billion pounds opportunity for the UK by turning buildings into power stations.

Image from SPECIFIC IKC

Opportunity & Drivers

Solar power offers a limitless energy supply, if we can effectively convert it, as it is estimated that enough solar energy falls on the Earth's surface every day to meet our global demand for the next 27 years![1] Photovoltaic (PV) conversion of that energy is capable of utilising the opportunity with minimal geographical restrictions, however the price per square metre for the PVs must drop significantly to provide a viable multi-terawatt scale solution. In terms of the global opportunity, the European Photovoltaic Industry Association (EPIA) believes that market evolution over the next five years will depend mainly on developments in Europe and the ability of policymakers to maintain market conditions at an acceptable level. In a Policy-Driven scenario, the European market ought to have stabilised first around 16-17 GW in 2013 before growing slowly again to around 25-28 GW five years on. In that case, the global market could top more than 84 GW in 2017, with two-thirds of this coming from new markets outside Europe. The new markets could help ensure major growth and robust market development in the following years. The EPIA expects the APAC region (without China) to represent between 10 and 20 GW each year until 2017. China alone could add 10 GW of PV installations each year, as announced by the Chinese authorities[2]. So with these growth figures in mind it is essential that non CRM reliant alternatives and flexible solutions are found.

SPECIFIC has co-located industrialists, scientists and technology developers, and have brought together materials technologies, processing technologies and market views to successfully exploit these opportunities.

Approach

Through partnership with academic groups and industrial organisations the SPECIFIC team have developed a unique printed solid-state device based on the hybrid photovoltaics technology that can be applied to glass or lightweight flexible substrates (pictured). At the same time, the centre is approaching the scaling challenges of three other promising emerging printable PV technologies by creating partnerships with the leading UK scientific teams from Bath, Imperial and Oxford. Printing processes offer a cost efficient means of depositing a pattern of functional materials which can be used for energy capture, storage and release. As the processes do not require vacuum, they typically have capital costs which are around 20% lower than vacuum deposition techniques and are suitable for continuous high volume manufacturing. The choice of printing (or coating) technology is made by marrying the detail, film thickness, volume and speed of the process with the physical characteristics of the functional "ink" being printed. The scale up from lab concept through to product is made possible by a series of pilot lines which have been designed to accommodate each of the printing processes to glass, plastic and metal substrates at appropriate scales. This is complemented by laboratory techniques which transform functional materials into process-ready inks.

The SPECIFIC approach essentially allows the partnership to be uniquely placed to explore and exploit the breakthrough materials technologies that are under development for low-cost PVs. SPECIFIC has a world lead and unique facilities for scaling these technologies on flat (e.g. glass) surfaces and flexible (plastic or metal) ones, on their three pilot manufacturing lines which were installed in 2013.

Benefit & Impact

The SPECIFIC team is developing a manufacturing pipeline for large scale roll-to-roll fabrication of solution-processable photovoltaics. In addition, they have been able to increase the efficiency levels of the PV structures to a level of 15% in the lab, which is comparable to inherently inflexible silicon or high CRM dependant technologies currently on the market.

By developing new flexible and lighter weight PV technologies that are based on earth abundant materials, product designers will able to utilise PVs in more creative and possibly demanding applications in terms of consumer products and the modern built environment.

As a UK consortium, the SPECIFIC partnership needs to be able to compete internationally in a very complex market in order to realise the benefits of a multi-billion pound opportunity for the UK. The team is well on the way to achieving its vision to turn buildings into power stations.

Image from SPECIFIC IKC

1. http://www.altenergy.org/renewables/solar.html
2. http://www.epia.org/fileadmin/user_upload/Publications/GMO_2013_-_Final_PDF.pdf

This case study was produced by the Materials Security Special Interest Group.