INDUSTRIAL PILOT PROJECT

Facilitating improved hole-transporting interlayers in organic solar cells using synchrotron radiation techniques

THE INDUSTRIAL CHALLENGE

Epishine AB is a young company (founded 2016) and is currently producing light-energy harvesting modules that harvest indoor light aimed at supporting low power devices. The long-term plan is to expand the product portfolio into many other solar cell applications.

Organic solar cells have undergone tremendous improvement during the last four years and now reach power conversion efficiency values of over 19% for single cells (AM1.5) and over 26% at indoor lighting conditions. However, continued advances are still needed to improve cell stability. For this improving the selective charge transporting interface layers between the light absorbing organic semiconductor blend layer and the electrodes is important. This project aims to facilitate the development of improved hole-transporting interlayers.

WHY USING A LARGE SCALE FACILITY

Synchrotron facilities enables the use of x-ray photoelectron spectroscopy (XPS) over a wide range of photon energies, not available at a typical local lab, and can also offer such experiments combined with oxygen/air exposure. This enables non-destructive depth profiling of the hole-transporting interlayers and the mapping out of vertical concentration gradients of the molecular components. In addition, the chemical modification of the interlayer upon exposure to air can be determined.

HOW THE WORK WAS DONE

We used the HIPPIE beamline at MAX IV that enables XPS over a wide range of photon energies as well as measurements under controlled exposure to gases such as air. We measured pristine interlayers on flexible foils from the production line (cut to ~1x1 cm^2 samples) as well as interlayers exposed to thermal stress, and tracked the vertical concentration gradient of the molecular components using elemental core level spectra taken at different photon energies. To study the possible effects of air exposure, we studied pristine never-exposed-to-air interlayer films inserted using a glove bag, as well as films that were exposed to air for different durations. Chemical and concentration changes were tracked by core level spectra.

THE RESULTS AND EXPECTED IMPACT

The results showed that molecular concentration gradients in the hole-transporting interlayers exist already before exposure to thermal stress. The concentration gradients, however, change upon thermal stress as well as after long-term storage at room temperature.

During short-term exposure to air (in situ), no detectable chemical changes occur, while new chemical bonds with oxygen can be detected after long-term exposure (ex situ).

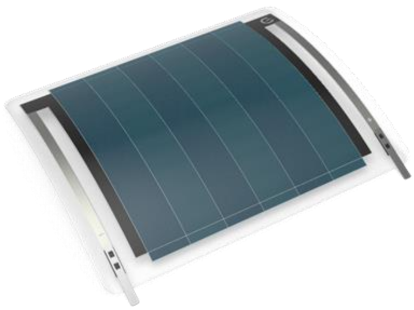

Figure. Examples of a curved solar cell device by Epishine AB.

"It is important for us to understand how our material is built up and how interact with the environment – HIPPIE provides the possibility to investigate this"
/Thomas Österberg, Epishine AB

epishine harvesting light

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