AGEING TESTS OF ORGANIC PHOTOVOLTAIC DEVICES FOR INDOOR APPLICATIONS

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Organic photovoltaic (OPV) have achieved remarkable power conversion efficiencies (PCEs) of more than 17% with the introduction of semiconducting non-fullerene acceptors (NFAs)[1], offering advantages vis-à-vis conventional inorganic solar materials, including mechanical flexibility, light weight, absence of toxic heavy metals and facile module manufacture by high-throughput printing methodologies[1,2].

In recent years, with the rise of connected devices and the internet of things (IoT), indoor organic photovoltaics (IOPV) have attracted attention because of their ability to power microelectronic devices and sensors, with a maximum theoretical PCE limit close to 50% under white LED illumination[3]. Among various potential technologies, OPV have been considered as a technology with great potential for indoor power generation due to several advantages of this technology: highly tunable optical absorption, large absorption coefficients and small leakage currents under dim lighting conditions[4], which are relevant factors, considering that indoor illumination has different light sources, including different spectra and they can have really-low light illumination compared with outdoor conditions with sun light.

Relevant research strategies are done to find new blends, devices configuration that fit well (with a good power conversion efficiency (PCE)) under the required indoor conditions[4]: specially trying to find high open circuit voltages (Voc) and shunt resistances (Rsh) in low illumination, while trying to maintain low series resistance (Rs) and good fill factor (FF) values. Further development of IOPV requires further scaling-up, keeping these requirements.

In indoor applications, environmental conditions seem to be less critical than for outdoor applications. However, new materials, device processing; their encapsulation and device configuration need to be tested to understand their behavior over time and degradation paths and try to improve their reliability along their lifetime.

The new application field also requires a deeper understanding of the environmental requirements and test proposal to simulate what the devices will face during their use conditions along their life to validate their stability. For these reason, relevant test procedures are being considered in the IOPV-lab, the common laboratory between CINaM, IM2NP and the company Dracula Technologies, to validate indoor conditions that are relevant to show real degradation mechanisms of these applications.

A comparison of relevant stability results of different indoor devices: with changes in material blends processing (with different donor:acceptor materials and solvents used), interlayers (with different thicknesses) and encapsulation will be shown in small size solar cell (0,16 cm^2) devices under the relevant indoor test conditions. Further preliminary results of larger area modules (≥ 20 cm^2) of some of these configurations will be shown.

With these results, we expect to develop a deeper understanding of the changes in the device and the affection of some of the materials or processes with the purpose of finding the most stable candidates for indoor applications and learn about its performance dependence over time, to develop reliable devices for indoor applications.

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[1] **Liao, Chuang-Yi, et al. « Processing Strategies for an Organic Photovoltaic Module with over 10% Efficiency ». *Joule* 4, nº 1 (2020): 189-206. https://doi.org/10.1016/j.joule.2019.11.006.**
[2] **Marrocchi, Assunta,, et al. « Poly(3-Hexylthiophene): Synthetic Methodologies and Properties in Bulk Heterojunction Solar Cells ». *Energy & Environmental Science* 5, nº 9 (2012): 8457-74. https://doi.org/10.1039/C2EE22129B.**
[3] **Xu, Xiang, et al. « An Overview of High-Performance Indoor Organic Photovoltaics ». *ChemSusChem* 14, nº 17 (2021): 3428-48. https://doi.org/10.1002/cssc.202100386**
[4] **Ryu, Hwa Sook, et al. « Recent Progress in Indoor Organic Photovoltaics ». *Nanoscale* 12, nº 10 (2020): 5792-5804. https://doi.org/10.1039/D0NR00816H.**