

## **State-of-the-art Perovskite PV – Scale-up Issues and Challenge**

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One of the challenges for Perovskite PV (PPV) is finding real solutions for future commercialization. The lab-to-fab technology transfer process, namely (i) proof of concept, (ii) prototype, and (iii) product development is driving the evolution of ONINN research and development efforts, enabling us to find solutions that can be applied for a future pilot production line. Balancing the need between thoroughly investigating technical issues and developing a commercially viable solution gives a different perspective on the research and development process.

Basic research is continually developing and understanding the interactions of materials to increase efficiency and lifetime but most of the time do not take in consideration the need in a large-scale production, such as solvent toxicity, materials degradation, the establishment of the supply chain, costs, and CAPital EXpenditure of the production line (CAPEX). Therefore, the technological scale-up, from small laboratory cells to real-size modules and panels, involves several steps and peculiarities.

In the field of Perovskite Solar Cell (PSC), the best results currently obtained on small devices are found on chlorinated or halogen-based inks processed in an inert atmosphere, which favor a better crystallization of the active layer and translate into higher performance. Furthermore, lead-based perovskites are the readiest option for a potential market in terms of performance and relative ease of manufacture. However, those formulations are not the best choice for scale-up due to health and safety concerns and best practices, requiring the development of safety control protocols that are not an issue in small-scale or laboratory research.

PPV scale-up from single cell up to modules as well as from base research up to production, needs not only performance in terms of efficiency and lifetime - solving problems of chemistry, physics, and process - but also development of usable



applications for a future market. In this way, the required research is often a dedicated development program for a single application. Unlike other types of photovoltaic technologies, developed on a single material optimized for multiple applications, PPV provides great opportunities for having different devices, materials and structures optimized for different applications with different characteristics.

From this point of view, we will present an overview of some of the challenges encountered in various technology development areas at ONINN, including blade coated devices, modules by R2R, encapsulation, lifetime, and modules scale-up.

**Keywords:** Perovskite, scale-up, mini-module, encapsulation, lifetime

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