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From stagnation to success: Recent breakthroughs in kesterite solar cell technology for indoor Photovoltaics

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After a decade of performance stagnation of Kesterite solar cells, recent breakthroughs in the materials deposition offering a high degree of control in elemental oxidation state have permitted to bring back this technology as a strong contender in the landscape of thin film photovoltaic materials. In the meantime, the emergence of the Internet of Things and the necessity to power autonomous sensors creates a need to exploit indoor illumination. Indoor Photovoltaics is becoming a new eldorado for photovoltaic materials with bandgaps above 1.5 eV, owing to a better spectral matching to the typical LED indoor light permitting single junction conversion efficiencies above 30%. The Kesterite family of absorber, with a bandgap tuneable all the way up to 2.0 eV, retains strong assets in terms of materials availability and low toxicity, and the recent performance progress is an opportunity for this technology to finally transition from the laboratory to industrial application.

In this presentation, we will in a first part detail the experimental conditions and methods which made possible the recent breakthroughs in the field of Kesterite, we will particularly emphasis the agility of the solution-based methods initially developed at Nanjing University of Post and Telecommunications and more recently refined at the Polytechnic University of Catalonia (beyond 14% AM1.5 efficiency). This will be supported by quantitative numerical modelling providing improvement pathways and application perspectives for tandem designs.

In a second part, we will present recent results of Kesterite solar cells in indoor conditions and compare those results with other technologies, such as CIGS, Sb_2S_3, CdTe, and organic. This work will also be supported by a strong background of device modelling explaining the interplay between illumination spectrum, low injection conditions and photovoltaic conversion performance.

In a third part, we will veer towards the characterisation aspect of this work. Indeed, no standard of indoor PV characterisation currently exists, and we will provide arguments as to why such standard shouldn't be pursued and instead propose an easy-to-implement characterisation method, applicable to the vast majority of PV-oriented groups, and providing a more relevant set of figures of merit incorporating the variability of indoor light, including both source incident power and temperature.

This presentation aims to offer a comprehensive overview of the recent breakthroughs in Kesterite solar cell technology, their suitability for indoor photovoltaics, and the development of experimental methods and characterisation techniques to facilitate their evaluation by the PV research community.