Final Report

Project acronym: *CLEARPV*

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M-ERA.NET Call 2016

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Coordinator:

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Publishable project summary

CLEARPV is an applied research project running between 2017-2020 in the framework of the M-ERA.NET scheme. A characteristic feature of the CLEARPV project is the live and relevant networking within the consortium. We form an outstanding and cohesive team to do the R&D of next generation low cost and high efficiency semi-transparent solar cells. The team consists of four members: (1) Distinguished Prof. Wei-Fang Su of National Taiwan University (NTU), (2) Prof. Akos Kukovecz of Szeged University of Hungary (SZTE), (3) Dr. Yulia Galagan of Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO) and (4) Dr. Hsueh Chung Liao of FrontMaterials Co. Ltd. of Taiwan (FM). Within CLEARPV project, we dedicate on the materials and processing of perovskite solar cells to pave an avenue to further commercialization.

The objective of this project is to establish a semi-transparent perovskite solar cell that can be implemented either on build-integrated photovoltaics or tandem solar cells. We complied with the theoretical models that support the design of macrostructures of materials and the chemical composition of materials. Scientifically, important results were achieved in developing the micro-CT measurement and analysis methodology of thin conducting films and in the synthesis of complex oxide structures directly applicable in photovoltaic devices. The knowledge explored within this project sheds light on the correlation between photovoltaic performance and defects management in such photovoltaics. Therefore, perovskite materials with tunable color perform an extremely high open-circuit voltage (Voc) of 1.23 V (Eg of perovskite material =1.70 eV) as assembling to a complete photovoltaic device. Also, an inverted semi-transparent device (0.09 cm2) with a progressive photoconversion efficiency of 17.20% also demonstrates in CLEARPV project.

Based on the advanced technology and understanding for small devices, we finally demonstrated a semi-transparent perovskite module, fabricated by using upscalable processing tools. The modules have been processed using slot-die coating technique, spatial ALD, and sputtering. Optimized laser interconnection routes resulted in geometrical fill factor values above 90%. The adopted new stack has made us achieve the target efficiency of 13%. The best module resulted in a PCE value of 14.4% at the reverse scan, which increased up to 15.0% after encapsulation.

Based on the progressive stability of perovskite materials achieved within CLEARPV project, the long-term stability of the perovskite solar cell can also be enhanced. The lifetimes of corresponding devices prolong to 1500 hours for damp-heat test, 100 times thermal cycle tests from -40 °C to 85 °C, and 1000 hours for light soaking tests. That reveals that the realistic lifetime of devices established in this project can be predicted to over 10 years. The achievements in CLEARPV project are promising to bridge the gap between this novel technology of perovskite solar cell and end-users manufacturing commercial products. That sheds light on the direction of this low cost renewable solar energy into reality.