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Reliability testing and infrastructure integration of colored lightweight PV modules based on polymeric honeycomb

Umang Desai[1], Leïla Mazirt[1], Antonin Faes[1,2], Christophe Ballif[1,2]

1: EPFL, PV-Lab, Maladière 71b, CH-2002 Neuchâtel[1]; 2:CSEM, Rue Jaquet-Droz 1, CH-2002 Neuchâtel[4]

Contact: Dr. Umang Desai: UMANG.DESAI@EPFL.CH, Dr. Antonin Faes: ANTONIN.FAES@EPFL.CH

1. Introduction and motivation:

- This work presents the results on the reliability testing of the lightweight PV modules based on polymeric honeycomb for building integrated photovoltaics (BIPV), using the materials sourced from Europe.
- Distinct features of the PV modules are below:
  - ✓ Use of coloured foils for improved aesthetics,
  - ✓ Weighing less than 6 kg/m^2,
  - ✓ Easy to integrate to the buildings, especially the old ones,
- The architecture of the PV modules is shown in Fig. 1 while the mini-modules employing dark grey and beige colored foils are shown in Fig. 2.

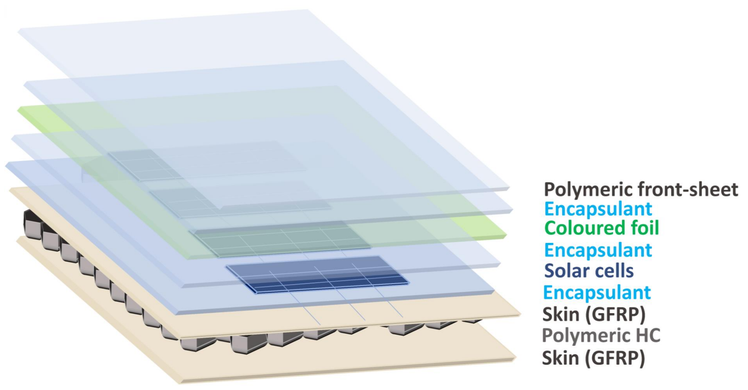

Fig. 1: Architecture of the light-weight PV modules based on polymeric honeycomb

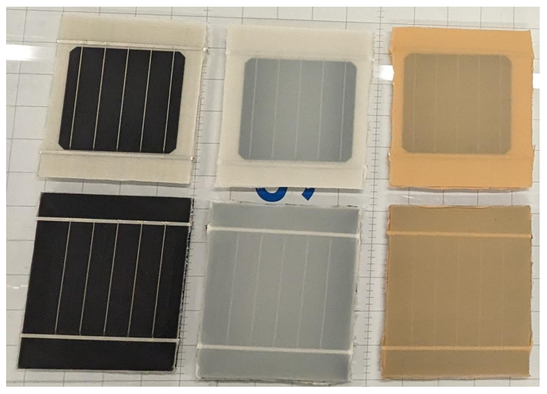

Fig. 2: Mini-modules with dark grey and beige colored foils

2. Reliability testing for mini-modules

- Climatic ageing:
  - ❑ Modules were subjected to DH 2000 h (Fig. 2), UV 60 kWh/m^2 (Fig. 4), 400 TC (Fig. 5) and 40 HF cycles (Fig. 6).
  - ❑ Most critical stress was identified to be DH ageing as it resulted in delamination close to the edge of the modules. Furthermore, a busbar was also found to fail resulting in higher series resistance of the module.
- Mechanical testing:
  - ❑ Three cycles of ±2400 Pa load with 1 h dwell time was applied to the modules. No new cracks were formed in the cells of the modules (Fig. 8).
- Flammability tests:
  - ❑ Flammability tests done as per ISO 11925-2 revealed that while the maximum flame travel remained below 15 cm for the first 20 seconds, the honeycomb structure at the edge of the modules suffered significantly.

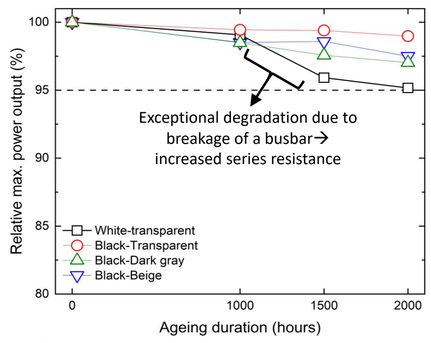

Fig. 2: Relative power loss against DH ageing duration

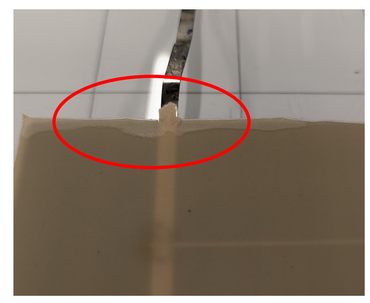

Fig. 3: Delamination close to the edge of the module

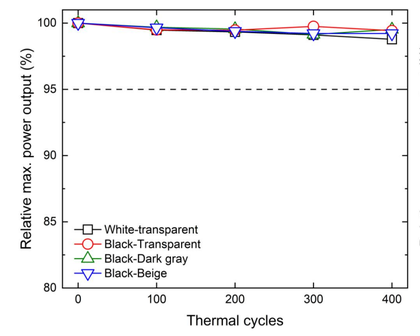

Fig. 4: Relative power loss against thermal cycling

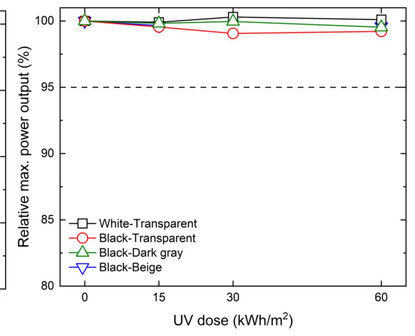

Fig. 5: Relative power loss against UV exposure

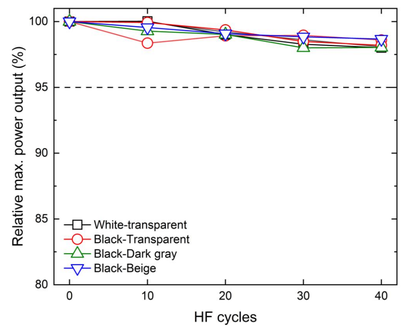

Fig. 6: Relative power loss against HF cycles

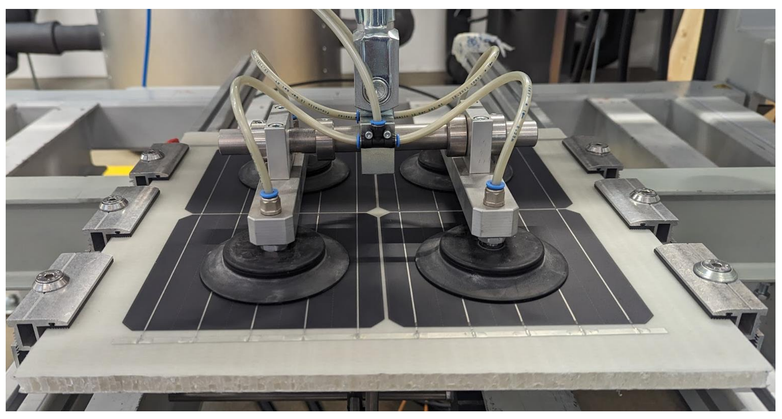

Fig. 8: Mounting of a 4-cell PV module for Mechanical loading consisting of three cycles of ±2400 Pa

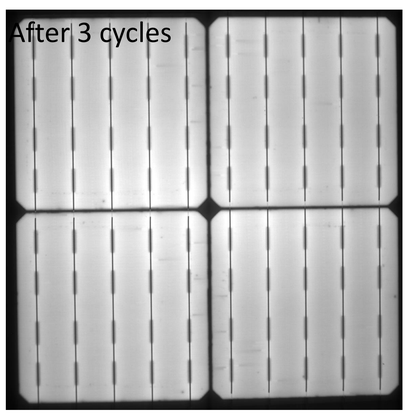

Fig. 9: EL image of the mini-module after three cycles

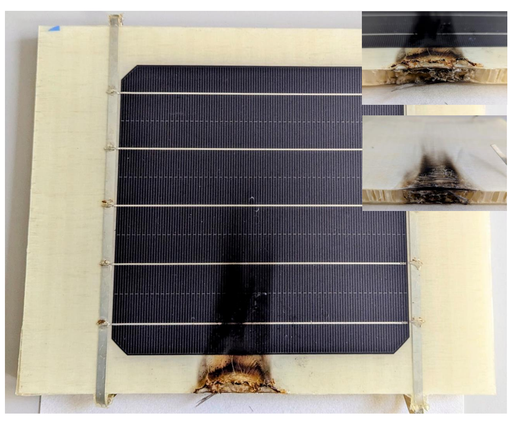

Fig. 10: Effect of fire exposure on the mini-module based on PP-1

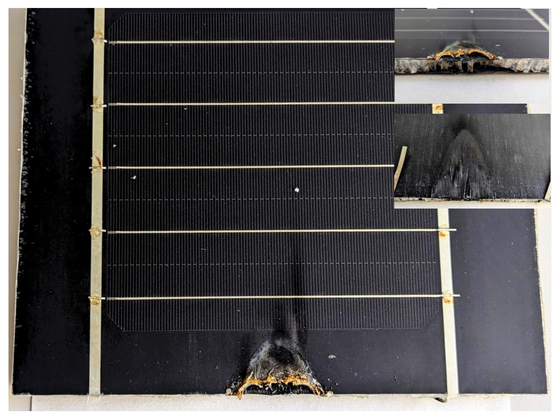

Fig. 10: Effect of fire exposure on the mini-module based on PP-2

3. Demo site at Neuchatel, Switzerland:

- Using the light-weight modules, a demo site was realized at the roof top of microcity building in Neuchatel, Switzerland.
- The modules are installed in the form of an East-façade.
- The modules containing white colored skins lacks aesthetic appeal since the profiles of the cells can be clearly seen even when a colored foil is used in the module. However, the modules employing black colored skins effectively hide the profiles of the cells and seamlessly integrates to the infrastructure.
- Currently, the modules are being tracked in the maximum power point tracking mode and periodically being traced for the performance in the standard test condition.
- During the exposure of the modules, the weathering data like, in-plane irradiance, air temperature, wind speed, etc. are being collected.
- Based on the available data and effect of the outdoor exposure for about a year, a detailed study will be presented in the future.

Fig. 11: The demo site depicting an East-facing façade realized using the lightweight PV modules

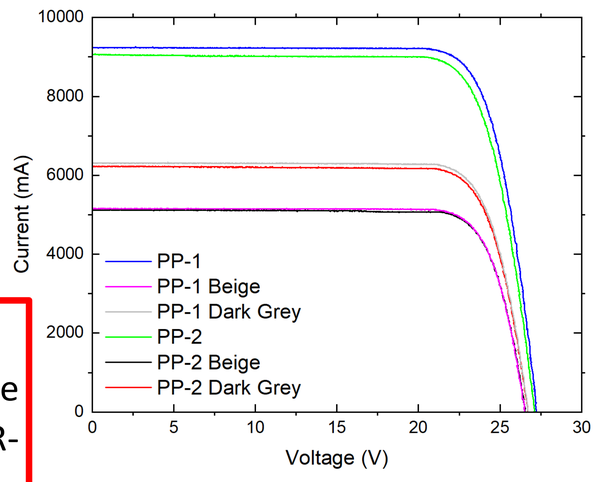

Fig. 12: Current-voltage curves for the LW PV modules installed in the form of the façade at STC

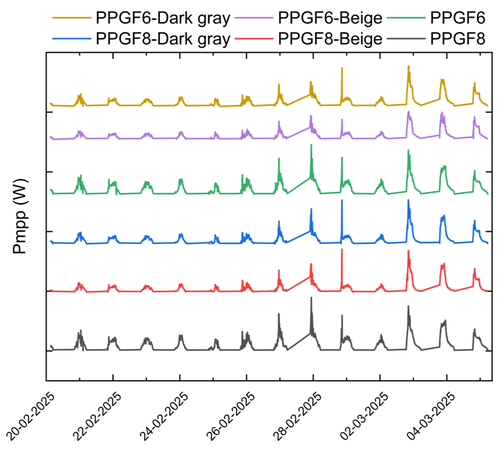

Fig. 13: MPP Power of the modules across different days

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