Stability of inks used for masking metallic interconnects in BIPV modules

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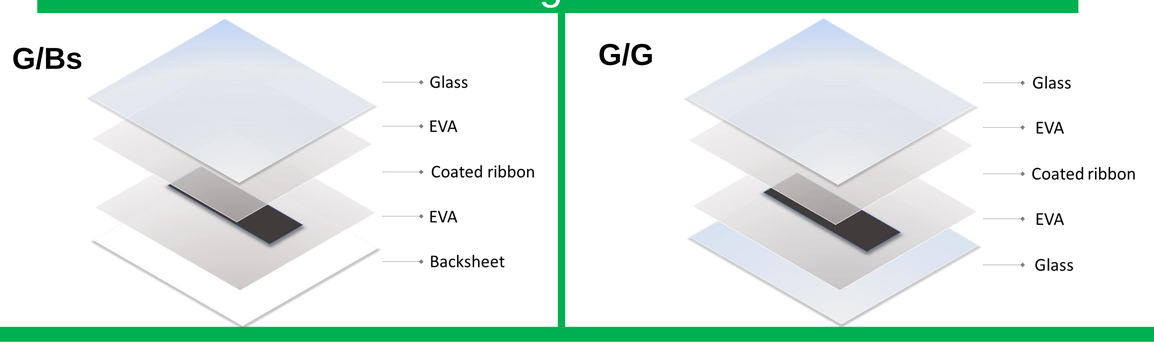
Motivation and Goals

- **Aesthetics** plays a **major role for integration** of PV modules in the built environment [1]
- Metallic interconnects are highly visible, so masking them can **improve the visual appearance** of a product
- Masking BIPV modules can be accomplished with inks [2]
- We investigate the **long-term stability of three commercial black inks** applied to the metallic ribbons using **2 different module configurations** under a **protocol** of ultraviolet (UV) exposure and damp heat (DH) conditions

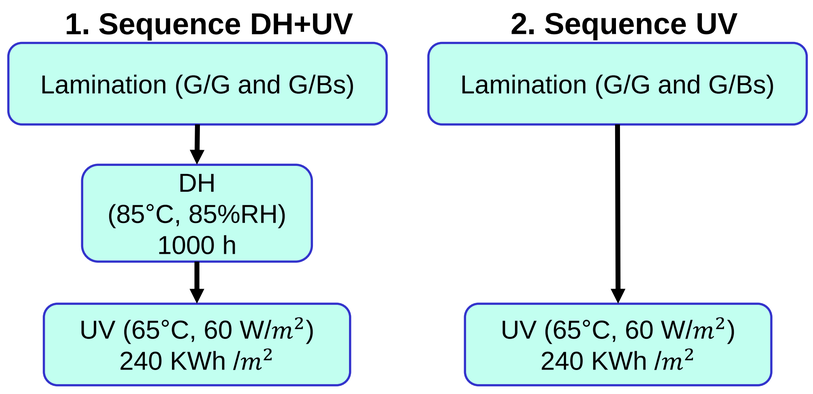
Configurations



Experimental

1) Three commercial black colored inks were used to mask the metallic ribbons in the G/G and G/Bs configurations

2) The samples are subjected to **2 main sequences**
   - **UV exposure** → IEC 62788-7-2 A3 conditions
     - Chamber air temperature: 65°C
     - Relative humidity: 20%
     - Lamp source Xe-arc lamp (with daylight filter)
   - **Damp Heat (DH)** → IEC 61215-2
     - Chamber air temperature: 85°C
     - Relative humidity: 85%

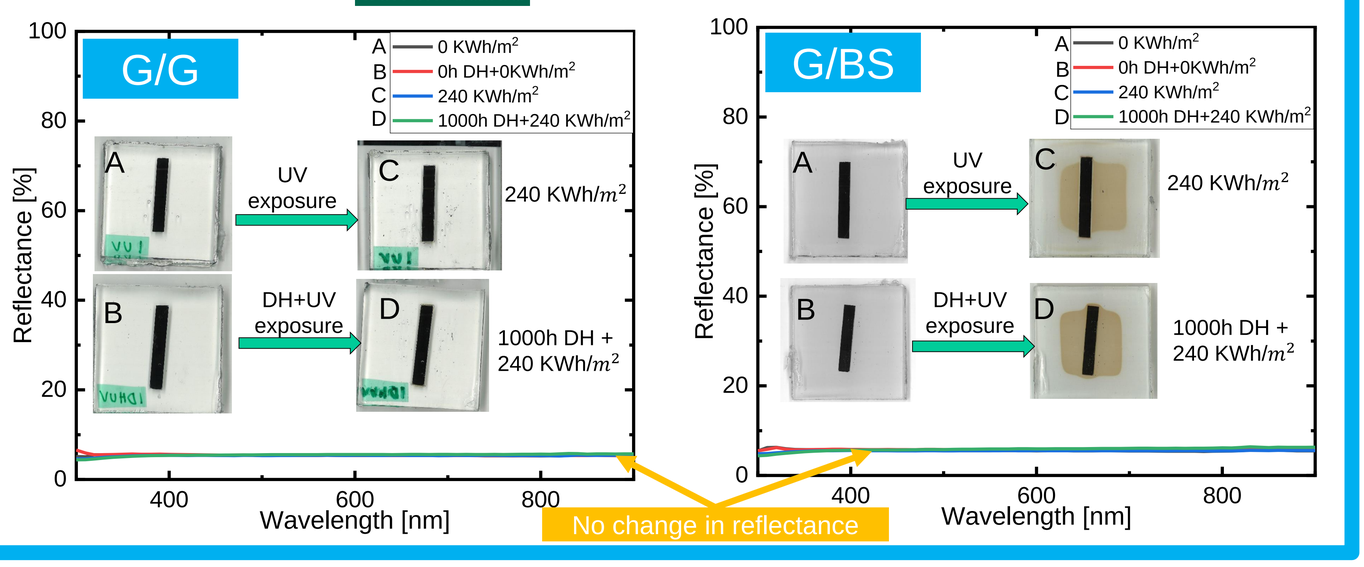


3) Characterization techniques

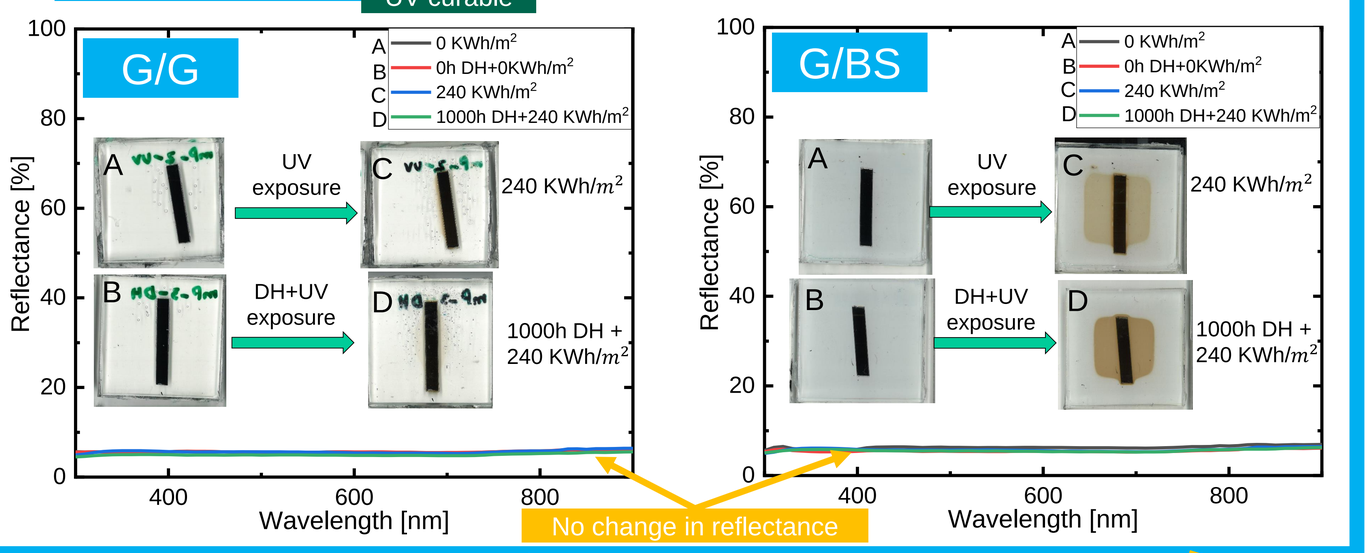
- UV-Vis-NIR spectroscopy
  - Reflectance from 300nm to 900nm of the masked ribbons
- Visual inspection
  - High and constant illumination

Results

Ink A — Solvent based

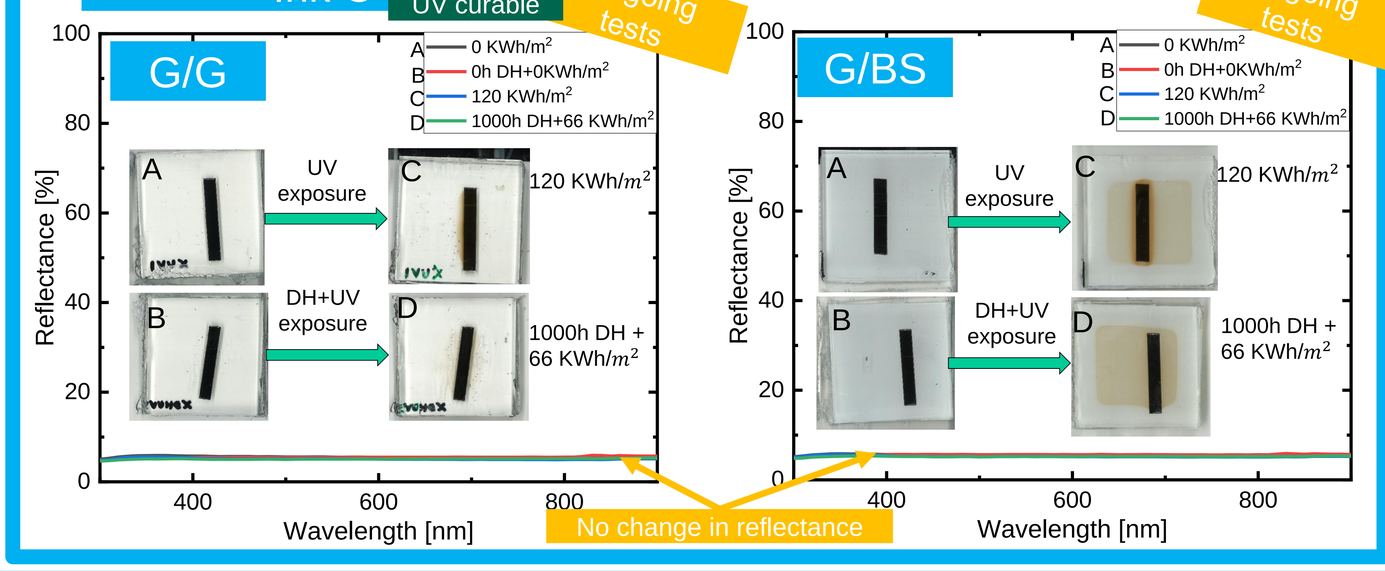


Ink B — UV curable



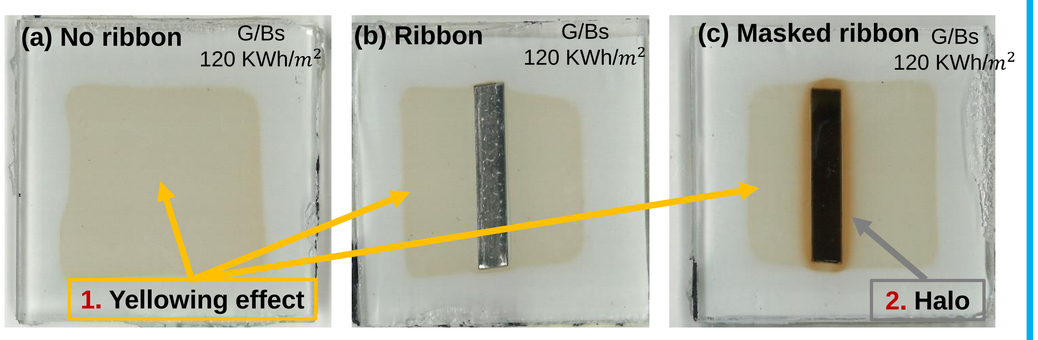
Ink C — UV curable

Ongoing tests



- **All inks are compatible** with conventional **lamination** processes
- There is **no change in the reflectance** of the metallic ribbons for any ink
- **The metallic ribbons preserve their black colored appearance** after UV exposure and DH+UV exposure
- **All samples with G/Bs configuration present a yellowing effect after UV exposure**, this effect is also shown in [3]
- **DH does not seem to contribute** to the yellowing effect
- **A halo is produced** in both configurations (G/G and G/Bs) of ink B and C following the sequence that **only involves UV exposure**
- **DH+UV exposure has not produced the halo** up to now (tests are **ongoing**, the sequences are not finished for ink C)
- **Ink C presents a larger halo** than ink B after UV exposure, while **ink A does not show it at all**
- **Ink A is more stable** than ink B and C

2 main effects



- **G/Bs** configuration after **120 KWh/m^2** of UV exposure
  - (a) without metallic ribbon
  - (b) with metallic ribbon
  - (c) with masked metallic ribbon with **ink C**
- The **yellowing effect does not depend on the ribbon** while **the halo effect depends on the ink**

Conclusions

- We study the stability of inks for masking ribbons in BIPV modules in G/G and G/Bs configurations following a protocol of 2 main sequences, UV and DH+UV.
- The metallic ribbons **preserve their black colored appearance** for all the studied inks and configurations.
- UV exposure produces a yellowing effect in all G/Bs configurations.
- **A halo is produced** in **all configurations** of ink B and C following the sequence that **only involves UV exposure,** the halo does not appears with ink A. It **might be ink migration to the encapsulant**. With **DH+UV exposure, the halo is not observed up to now**. Further investigation will be done.
- Ink A is more stable than ink B and C

[1] C. Ballif et al., 2018, DOI: 10.1038/s41560-018-0176-2
[2] L. H. Slooff et al., 2018 DOI: 10.4229/35thEUPVSEC20182018-6AO.8.4
[3] J. Kim et al., 2021 DOI: 10.1109/JPHOTOV.2021.3053657

Acknowledgments

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