

Direct Measurement of the Moisture Content in PV modules

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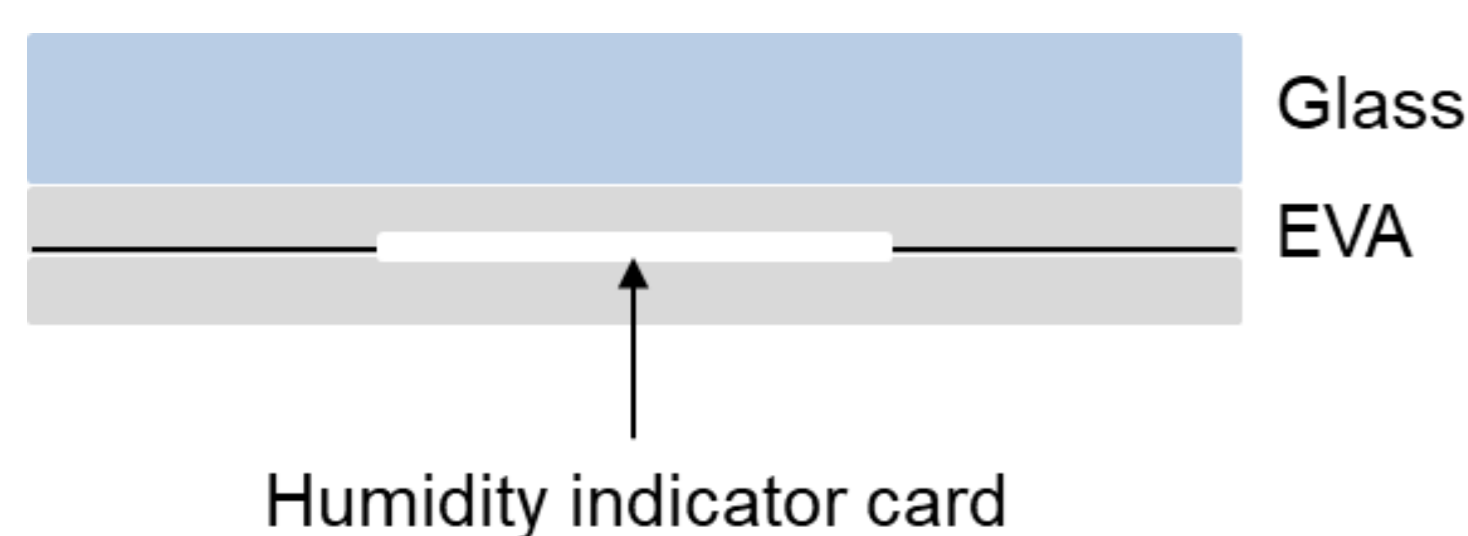
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ABSTRACT

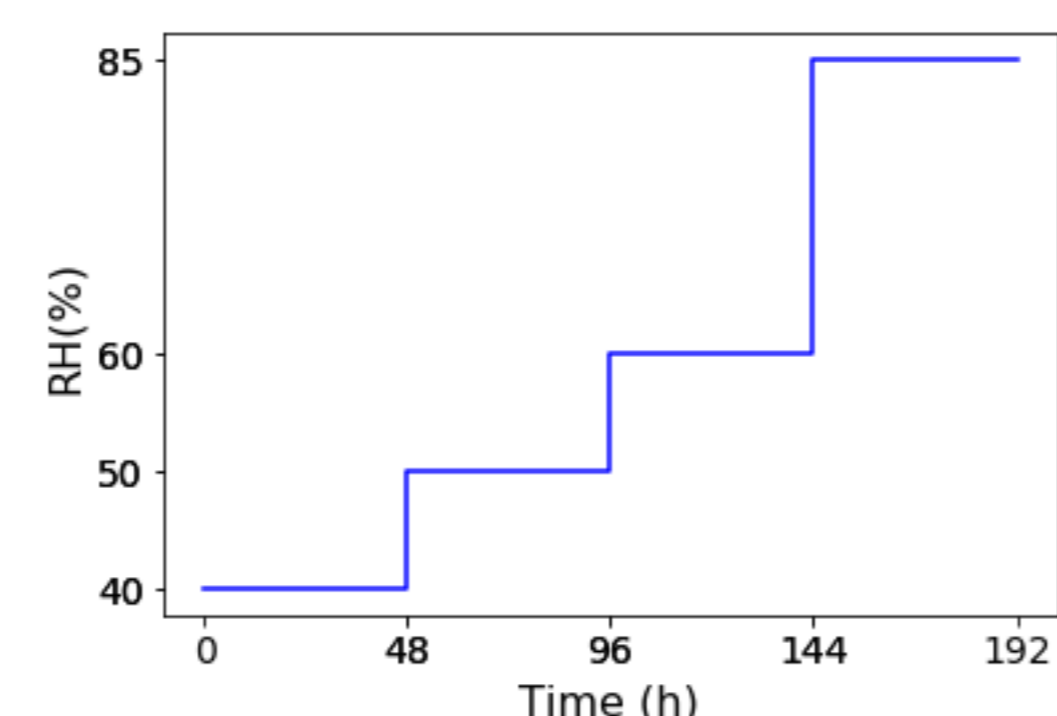
This work demonstrates a novel method of measurement of moisture ingress into PV laminates, by the encapsulation of humidity indicator cards into the structure. The change in colour of the humidity indicator cards due to moisture exposure is measured by a spectrophotometer. For the matching of the variance of colour to humidity measurements, a detailed calibration is first performed. To achieve this, laminates with the structure [EVA-humidity indicator card-EVA-glass] are stabilised in an environmental chamber sequentially at different relative humidity conditions. The reflectance spectra of the humidity indicator cards will be translated into RGB colour coordinates.

EXPERIMENTAL SET UP

Structure of samples



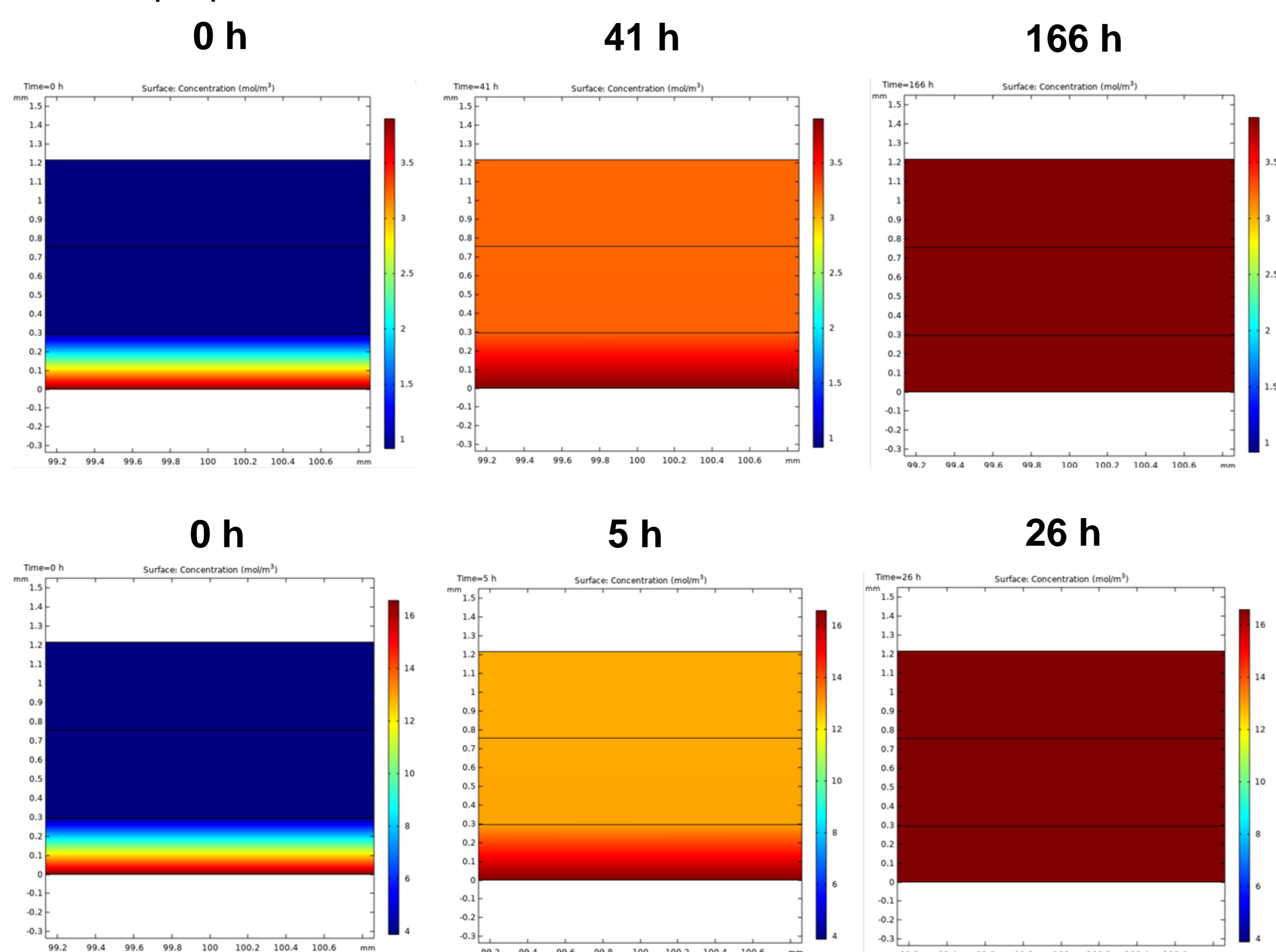
Chamber's conditions (T= 85°C)



The humidity indicator cards include dots constructed by blotting paper soaked with cobaltous chloride, which is sensitive when it is getting in touch with moisture. Each dot is soaked in different concentration of cobaltous chloride, for measuring different levels of humidity [1]. However, by choosing the appropriate dot, measurement for more moisture levels can be achieved.

MOISTURE ABSORPTION

A sample in the structure of glass-EVA-EVA-PET back sheet stored in chamber conditions 50°C/85% RH and 85°C/85% RH, needs 166 and 26 hrs respectively to get saturated according to simulations by Comsol Multiphysics. Validation of the results will be done by the measurement method proposed in this work.



REFERENCE

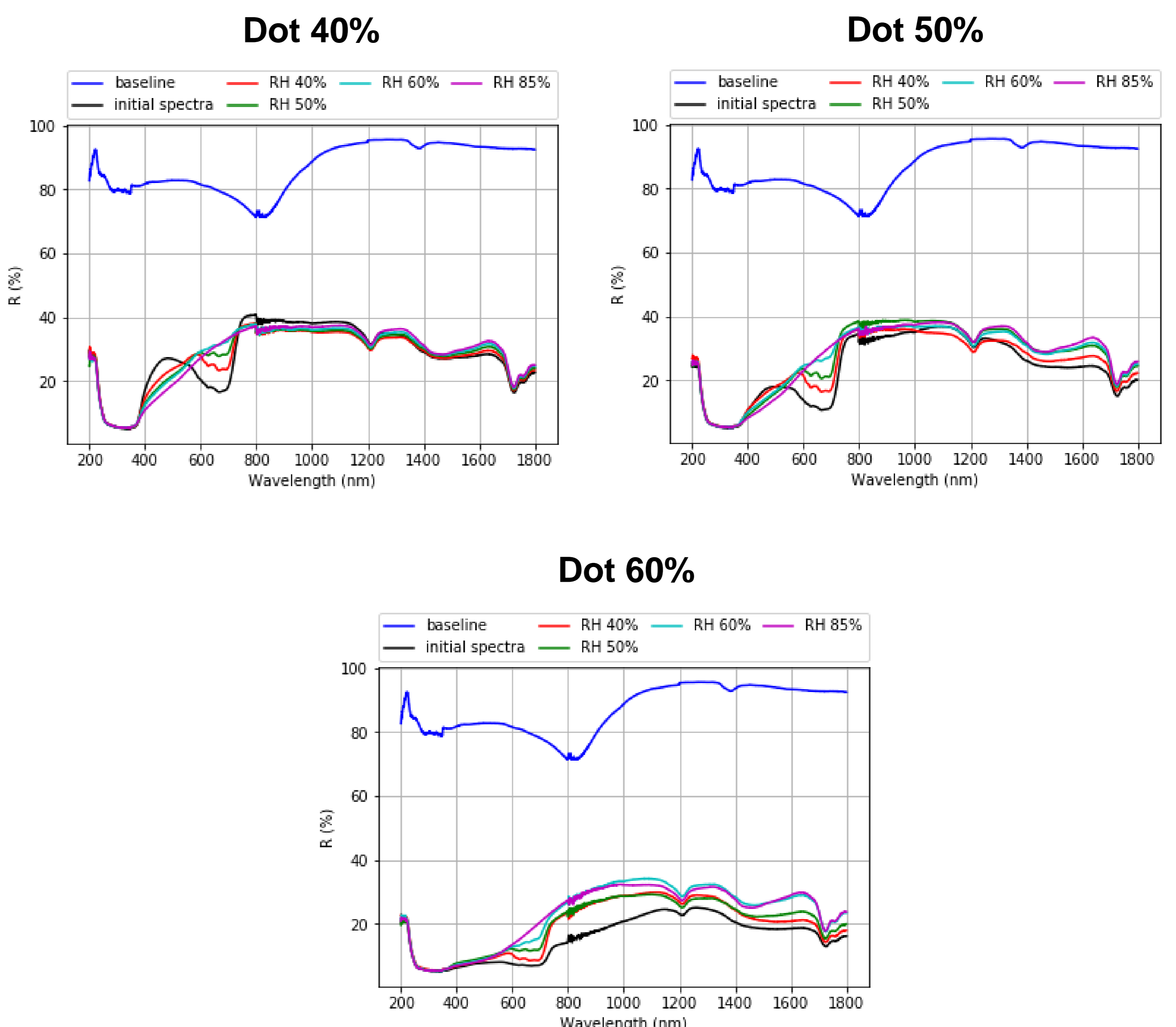
[1] 3M™ Humidity Indicator Cards (HICs) datasheet, [Online]. Available: <https://docs-emea.rs-online.com/webdocs/1446/0900766b81446f54.pdf> [Accessed: 24-Apr-2019]

HUMIDITY INDICATOR CARDS BEHAVIOUR

The change of the colour of the humidity indicator cards according to the level of the humidity absorbed (40%, 50%, 60% and 85%) is visible at the pictures below. The colour change is more obvious for the dots that measure up to 40% and 50% of relative humidity, than the dot that measures up to 60% of relative humidity. This dot is darker and can't detect accurately the low levels of relative humidity.



In the pictures below, the change of the reflectance spectra of each dot according to the level of the relative humidity exposed, is presented. For all the dots it is observed that the peaks of their spectra "move" from the blue/green towards the yellow/orange wavelengths. Two sharp peaks are observed for all the dots around the 590 nm and the 630 nm until all the concentration of cobaltous chloride has reacted with moisture. The spectra changes observed for the dot that measures up to 60% of relative humidity are less clear than the spectra of the other two dots.



Summary-Future work

- The reflectance spectra of the dots that can measure up to 40% and 50% of relative humidity change clearly according to the level of the moisture that are exposed, indicating that both the dots can be used for measuring the moisture content of PV modules.
- The full calibration of the measurement method will be presented at the **36th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC)** as a visual presentation with the title: "Direct Measurement of Moisture Ingress in PV Laminates" (4AV.1.24)

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