POLYMER COMPETENCE CENTER LEOBEN GMBH

Measurement of the water vapour transmission rate of high barrier films at service relevant conditions

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Introduction

- The ingress of water vapour correlates with failure rates in PV modules especially in OPV and thin-film modules
  - Therefore water vapour transmission rates (WVTR) of 10^{-4} to 10^{-6} g/m²day for encapsulating films should be achieved
- Commercial available test devices are not able to measure such low WVTR and non-commercial available test methods having drawbacks
  - Consequently there is a high demand for an advanced measurement technique for high barrier films

Objective & methodology

- Adaption of a measurement technique for detection of the WVTR in an extended range of 10^{-6} to 10^{3} g/m²day at temperatures from 20 to 100°C.
- Methodology

1.step: Evaluation of detection methods → Selection of detection method → Conception and Installation

2.step: **Leak tightness** → Calibration **high concentrations** → Calibration **low concentrations**

Assembly

Gascell-attachement with heating jacket
- Enables detection of gas mixtures
- Due to the lengthening of the IR-beam→ low detection limit 125ppm (calculated detection time for a film in equilibrium with a WVTR of 10^{-6}g/m²day= <3days)
- Heating jacket→ temperatures up to 100°C possible

Climatic chamber
- Temperature range 20 to 100°C
- Relative humidity range 10 to 98%

Permeation cell
- Enlarged permeation area→ lowered detection time
- Permeation area open to climatic chamber

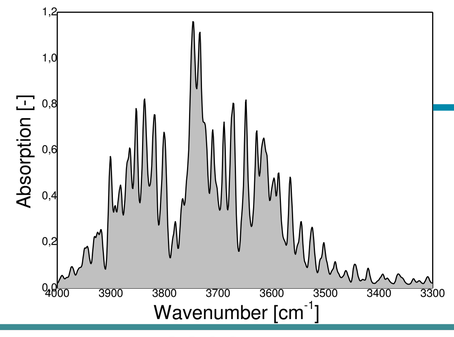
Cover
- Desiccant inside→ reduces humidity of surrounding

Common FTIR-spectrometer
- Enables detection of water vapour

Purging box
- Nitrogen purging of valves+ pump

Results

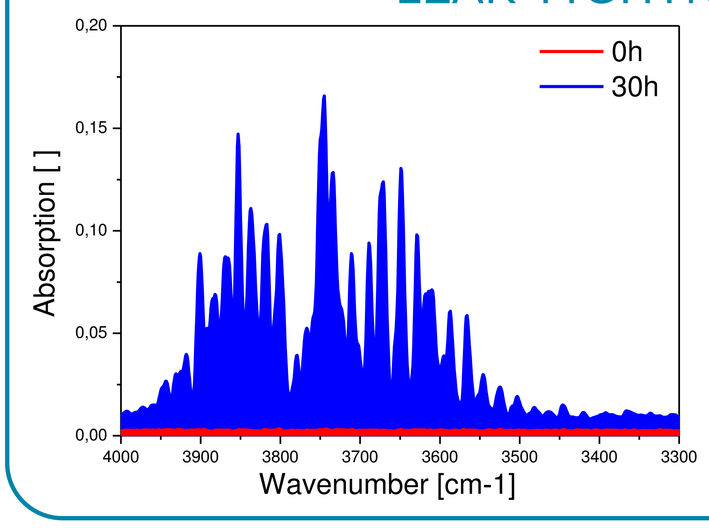
EVALUATION



→ Max. resolution when using area over a wide wavenumber range

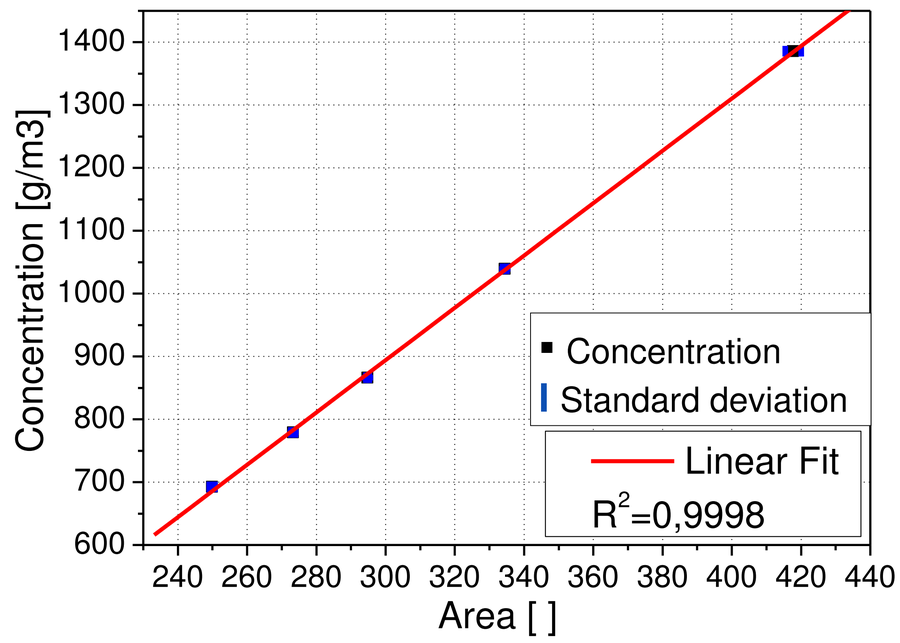
$$Area = \frac{\sum_{4000}^{3300} Absorption * Wavenumber}{\sum_{4000}^{3300} Wavenumber} * 1000$$

LEAK TIGHTNESS



After 30h 0,66g water in system→
- Very low amount (100% leak tightness not possible), but with controlled atmospheric conditions in our laboratory correctable!
- For measurements at low concentrations further optimisation required!

CALIBRATION



Calibration curve with linear approach
- For every point- average of 10 measurement points were taken into account (recorded on two different days)
- Standard deviation nearly zero

→PERFECT LINEAR FIT at high concentrations

→ Calibration for low concentration has to be done!

Conclusion

- The WVTR test device was concepted and assembled
- The perfect linear fit of the calibration curve at high concentrations proved the suitability
- Further optimisation of the leak tightness as well as the calibration for measurements at low concentrations has to be done

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