PV MODULE LIFE TIME FORECAST AND EVALUATION

Permeation behavior and PV polymer degradation

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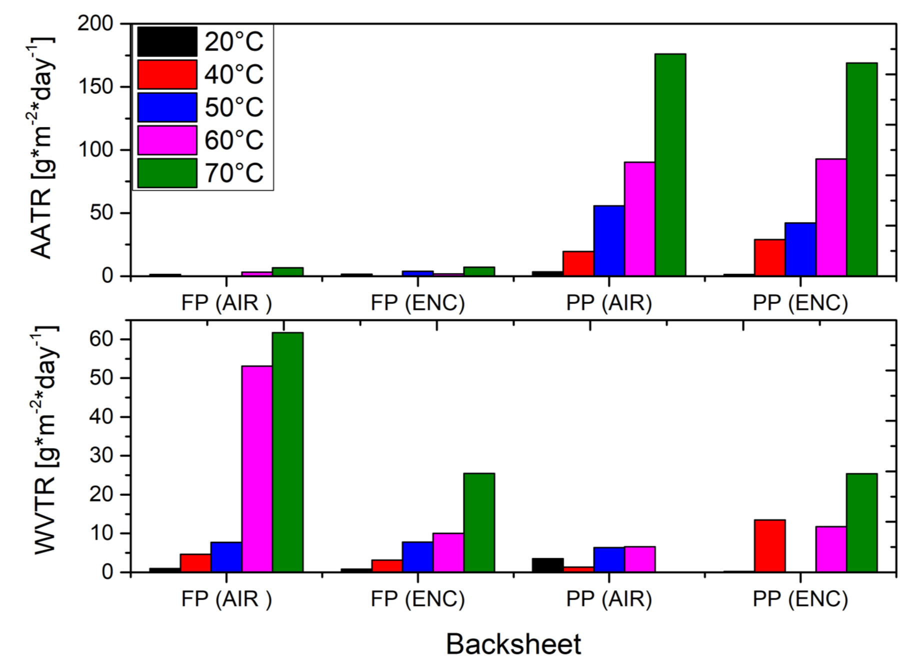
INTRODUCTION AND OBJECTIVE

- Continuing the work on the characterization of water vapor and acetic acid transmission rates by gravimetric means for different types of polymeric backsheets used in PV modules, it has been observed that after finalizing the gravimetric measurements some polymeric films present sign of polymer degradation, such as delamination and a noticeable change in color.
- The objective of this work is to study the changes in the structure and surface chemistry of the backsheets due to water vapor and acetic acid permeation.
- ATR Infrared spectroscopy (FTIR) was used to study the surface chemistry, and Differential Scanning Calorimetry (DSC) was sued to determine the melting enthalpy of the materials as well as other thermal processes.



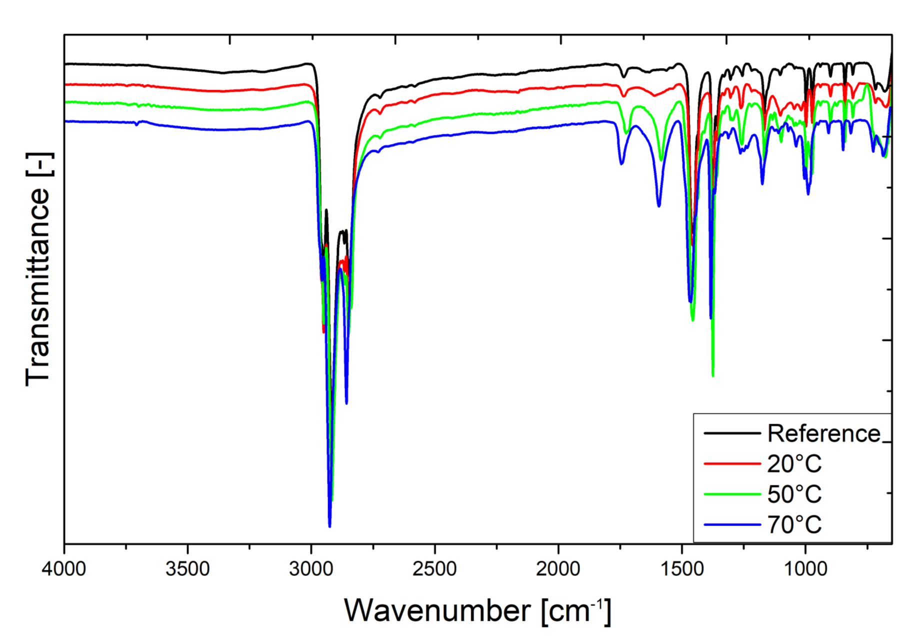
Observed permeation behavior and selectivity of two different backsheets with different composition and architecture.

EXPERIMENTAL

- Three different types of backsheet: a multilayer polyamide-aluminium (PA-ALU)backsheet, a fluoropolymer-PET (FP) multilayer backsheet and a polypropylene (PP) based backsheet.
- Permeation for a period of 20 days (~500h).
- Penetrants: water and acetic acid vapor.
- Temperatures: 20°C, 50°C and 70°C.
- DSC measurements: 10K/min with N_2 atmosphere.
- FTIR: measurements over both sides of the backsheet.

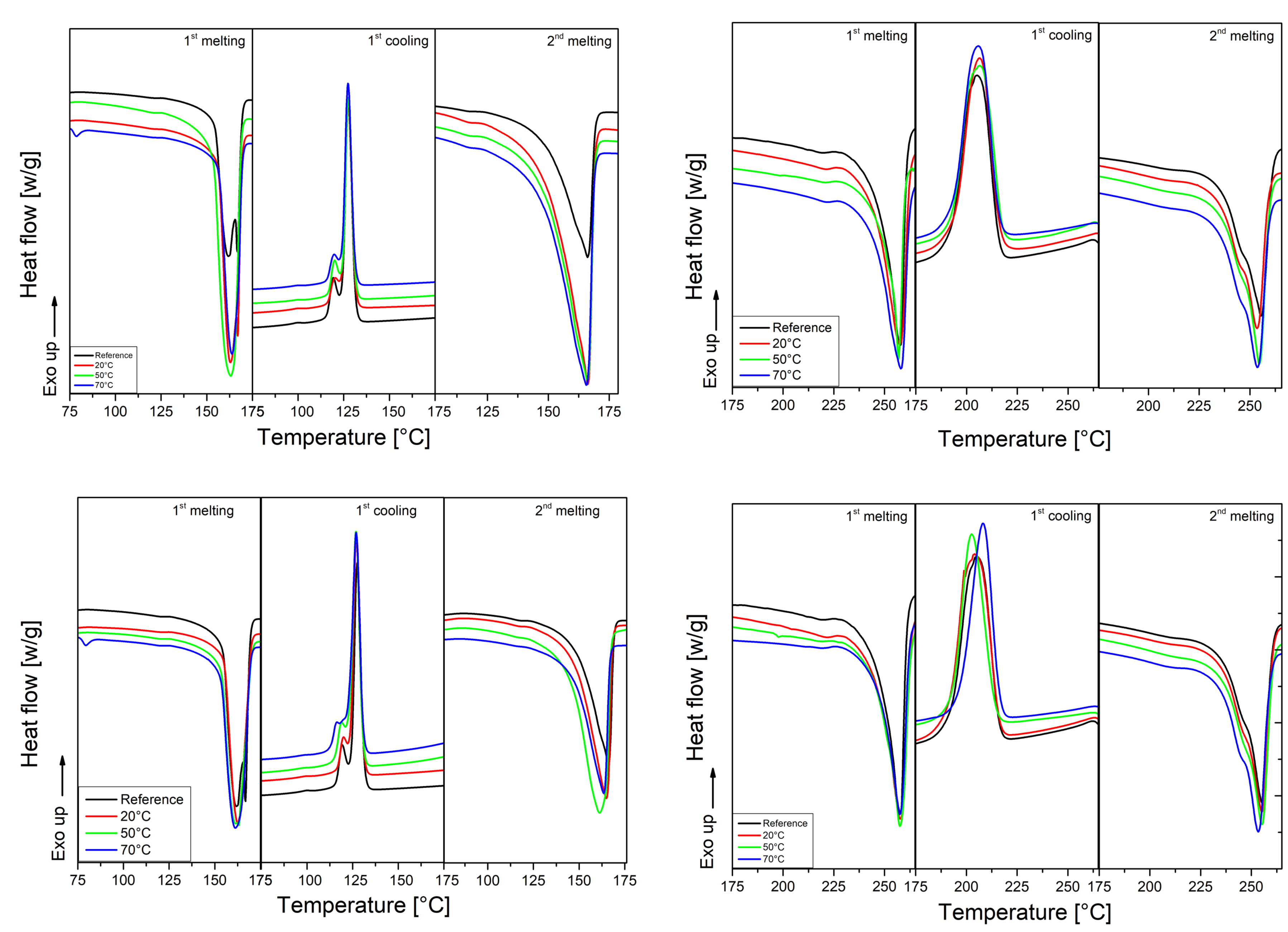
FTIR investigation

Delaminated and degraded PA-ALU backsheet.



FTIR spectra of a permeated PP backsheet using acetic acid as penetrant at different temperatures.

DSC investigation



DSC melting, cooling and second melting curves of permeated samples at different temperatures: water through PP (top left), water through FP (top right); PP (bottom left), acetic acid through FP (bottom right).

RESULTS

- FTIR spectroscopy show that acetic acid has an impact on the surface's chemistry of the backsheet. This effect is more notorious for the PP backsheet in which past 50°C at the -1723 cm-1 and -1523 peak, as well as an increase in the -1175 peak.
- DSC investigations point that although the melting and crystallization peaks remains almost the same there are slight changes in the curves due to permeation.
- For the PA-ALU backsheet it has been observed that after water and acetic acid permeation experiments the PA outer layer delaminates from the aluminum layer partially
- The PP and FP backsheets present less visible degradation.

CONCLUSION

- Prolonged gravimetric permeation experiments produce a thermochemical stress on the backsheets.
- Continuous permeation of water and acetic acid has an impact on the surface of the backsheets.
- Internal polymer morphology changes due to permeation can be monitored via DSC, and it is useful to understand the effect of each penetrant.
- The observed degradation behavior could be helpful to understand polymer degradation in real-life scenarios.

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