Failure mechanisms of aged glass laminates based on polar ethylene copolymer film adhesives

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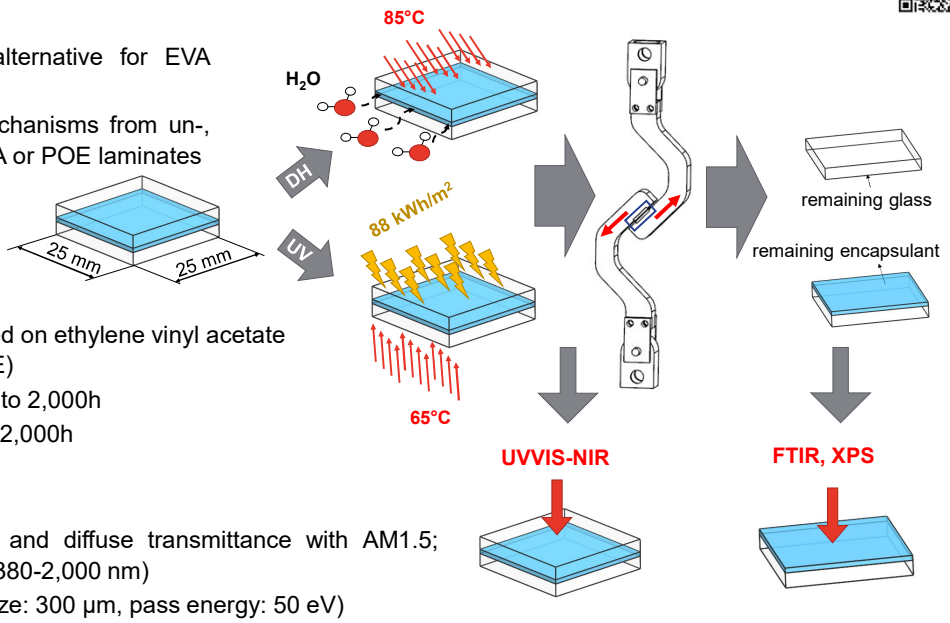
Introduction

- less polar POE has been established as alternative for EVA encapsulants to avoid PID effects
- **main objective:** characterization of failure mechanisms from un-, damp heat- (DH) and UV-aged double glass EVA or POE laminates



Experimental

Materials & ageing conditions:

- low iron solar glass (non-thermally toughened)
- UV-transparent, crosslinking encapsulants based on ethylene vinyl acetate copolymer (EVA) and polyolefin elastomer (POE)
- damp heat (DH) exposure, 85°C, 85 %rh for up to 2,000h
- UV exposure, 85 kWh/m² 65°C, 9 %rh for up to 2,000h

Characterization methods:

- UV-VIS-NIR:
  - ➢ Haze evaluation: weighting of hemispheric and diffuse transmittance with AM1.5; normalization by hemispheric transmittance (380-2,000 nm)
- XPS: X-ray photoelectron spectroscopy (spot size: 300 µm, pass energy: 50 eV)
- FTIR-ATR spectroscopy (4 scans averaged, 650-4,000 nm, spectral resolution: 4 cm^{-1})

Results & Discussion

Haze:

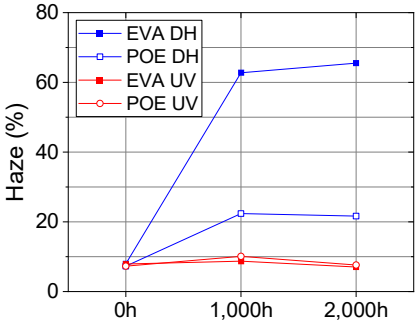
- significant DH induced increase in haze due to water uptake in both laminates
- no changes in haze due to UV ageing

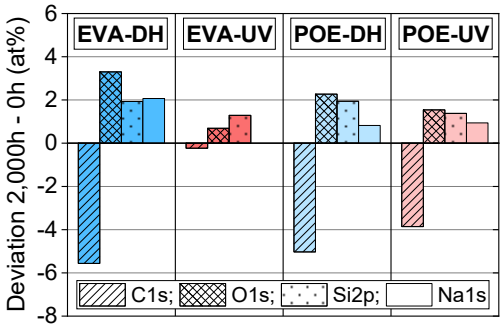
nm surface structure (XPS):

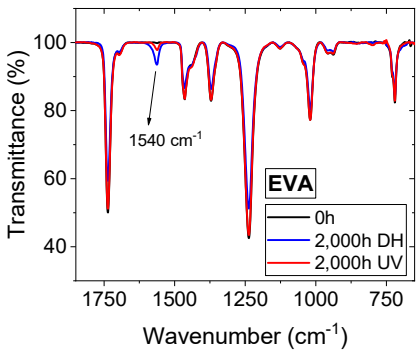
- increased amounts of oxygen and silicon in after ageing
- accumulation of Na at the interface after DH exposure (glass corrosion):
  - ➢ most pronounced for DH aged EVA laminates
  - ➢ not observed in UV aged EVA laminates

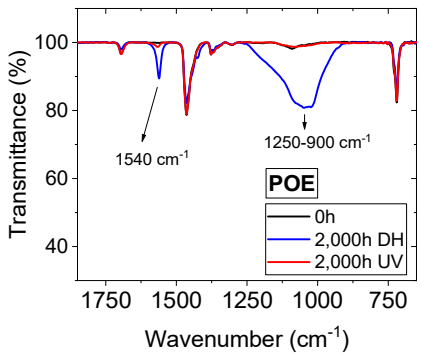
µm-surface structure (ATR):

- carboxylic acids (1540 cm^{-1}) detected on EVA and POE after 2,000h of DH and UV ageing
- peaks at 1540 cm^{-1} were more pronounced after DH ageing
- broad band at 1250-900 cm^{-1} attributed to silicon glass observed in DH aged POE laminates → failure in glass next to interface









Conclusions and Outlook

- significantly increased haze values were detected in DH aged laminates; haze values were not affected by UV ageing
- XPS revealed increased O, Si and Na contents at the interface of aged laminates; highest Na content detected for DH aged EVA
- the interface chemistry was more affected by DH than UV ageing; DH aged POE revealed a peak attributed to silicon glass
- **outlook:** subsequent UV and damp heat ageing of double glass laminates based on UV-transparent encapsulants

Acknowledgement

The financial support by the Austrian Federal Ministry for Digital and Economic Affairs, the National Foundation for Research, Technology and Development and the Christian Doppler Research Association is gratefully acknowledged.