

# Soft adhesives for barrier laminates

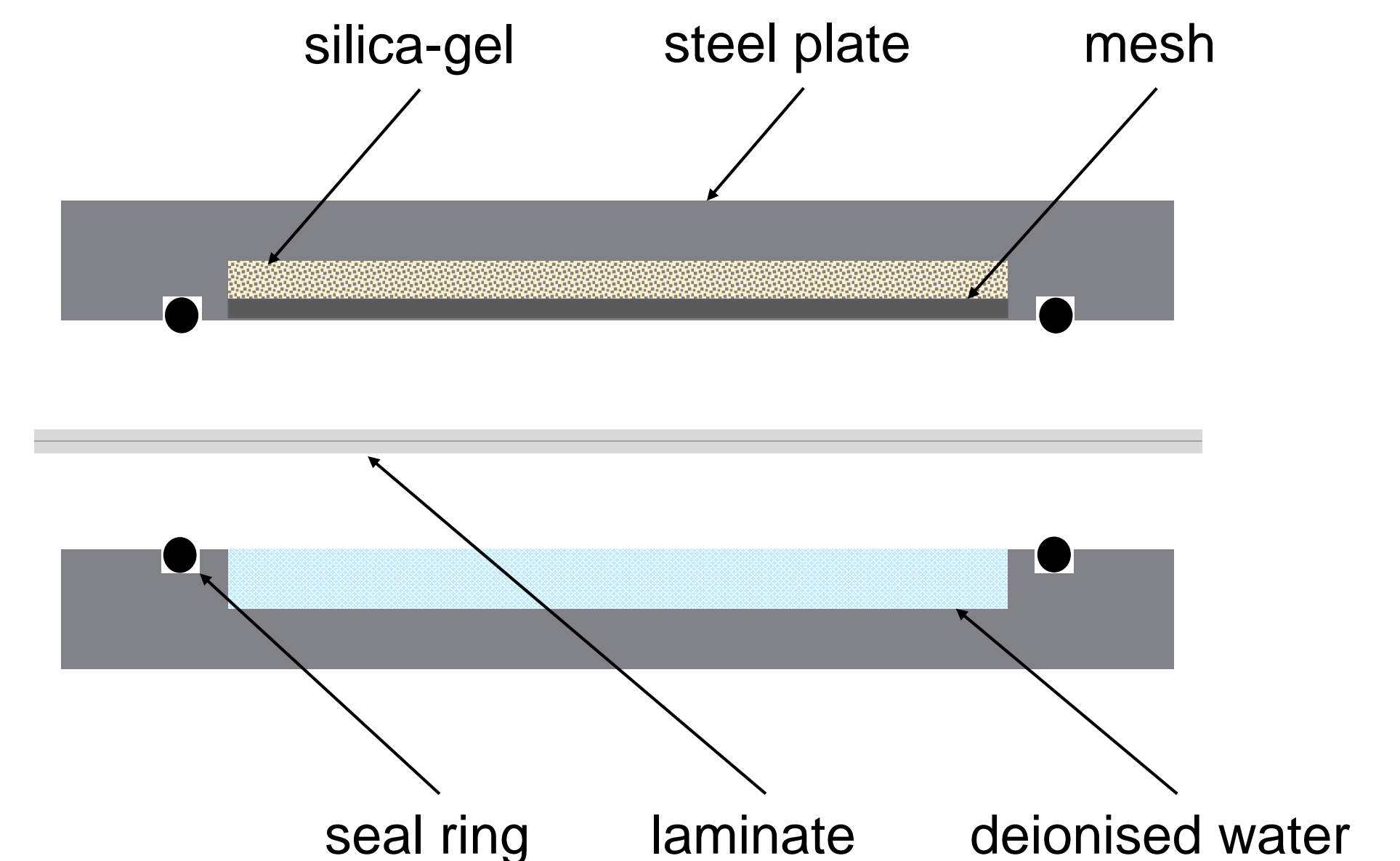
## Implementation of a testing device and evaluation of ageing behaviour

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## Introduction

- Large thermal energy storages are essential for renewable energy systems
- Increasing operating temperature up to 95°C
- Currently polyolefin based liners without gas barrier layer are used
- Development of new high-barrier laminates based on polyolefins, soft adhesives and metal films
- Implementation of a service oriented ageing testing method
- Evaluation of water vapour barrier properties and delamination behaviour



## Experimental

### Materials, Specimen & Ageing Conditions

- Barrier liner laminate
  - Liner: polypropylene-random-copolymer (PP-R)
  - Adhesive: ethylene acrylate-vinyl silane-terpolymer (EVSi)
  - Barrier: aluminium films / EVSi / glass fibre mesh
- Exposure at 95°C using stainless steel flanges with disc pockets
  - dry side: silica gel
  - wet side: deionised water
- Exposure time up to 7.150 hours (ongoing)



### Material and Laminate Characterization

- FTIR-Spectroscopy – Ulbricht globe
  - Silicon-Oxide-Index (SiO)
    - 1017 cm<sup>-1</sup>: SiO-stretching vibration, normalized by
    - 720 cm<sup>-1</sup>: CH<sub>3</sub>-rocking vibration
- T-Peel delamination testing
  - Testing rate: 10 mm min<sup>-1</sup>

$$\text{Peel energy: } W = \sum_i \Delta W_i = \int_{25\text{mm}}^{125\text{mm}} \vec{F}_i(\vec{s}) * d\vec{s}$$

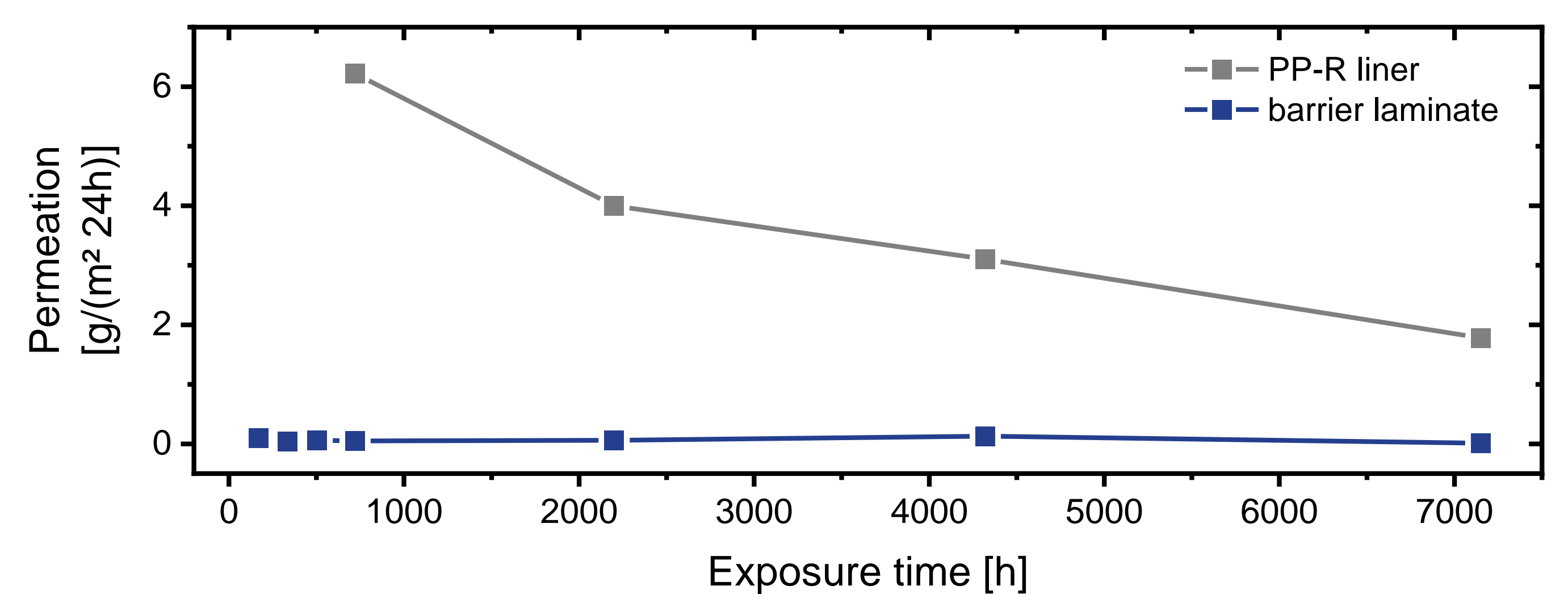
## Conclusions

- Negligible permeation rates for barrier liner laminate
- Silane cross-linking of soft adhesives
- Prolonged exposure → thermo-oxidation and hydrolysis → stabilisation

## Results & Discussion

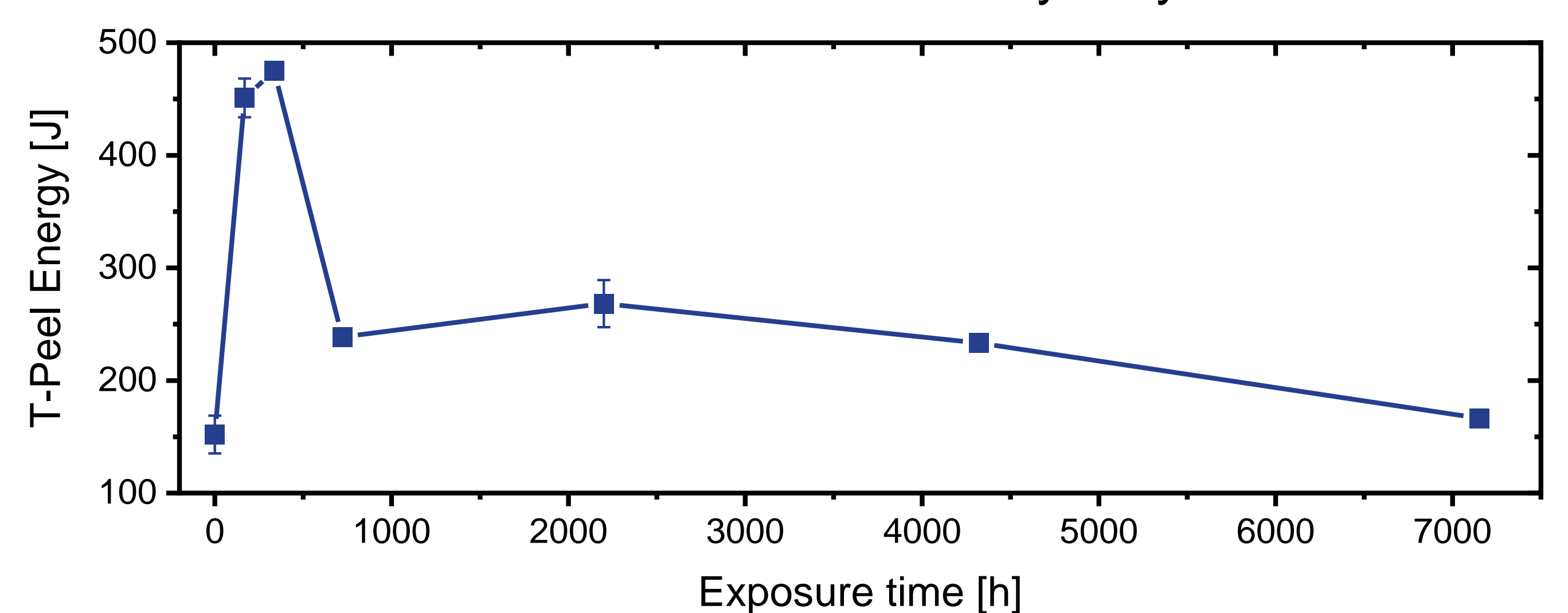
### Permeation behaviour

- High permeation rates of 2 mm thick PP-R liner
- Negligible permeation for barrier liner laminate



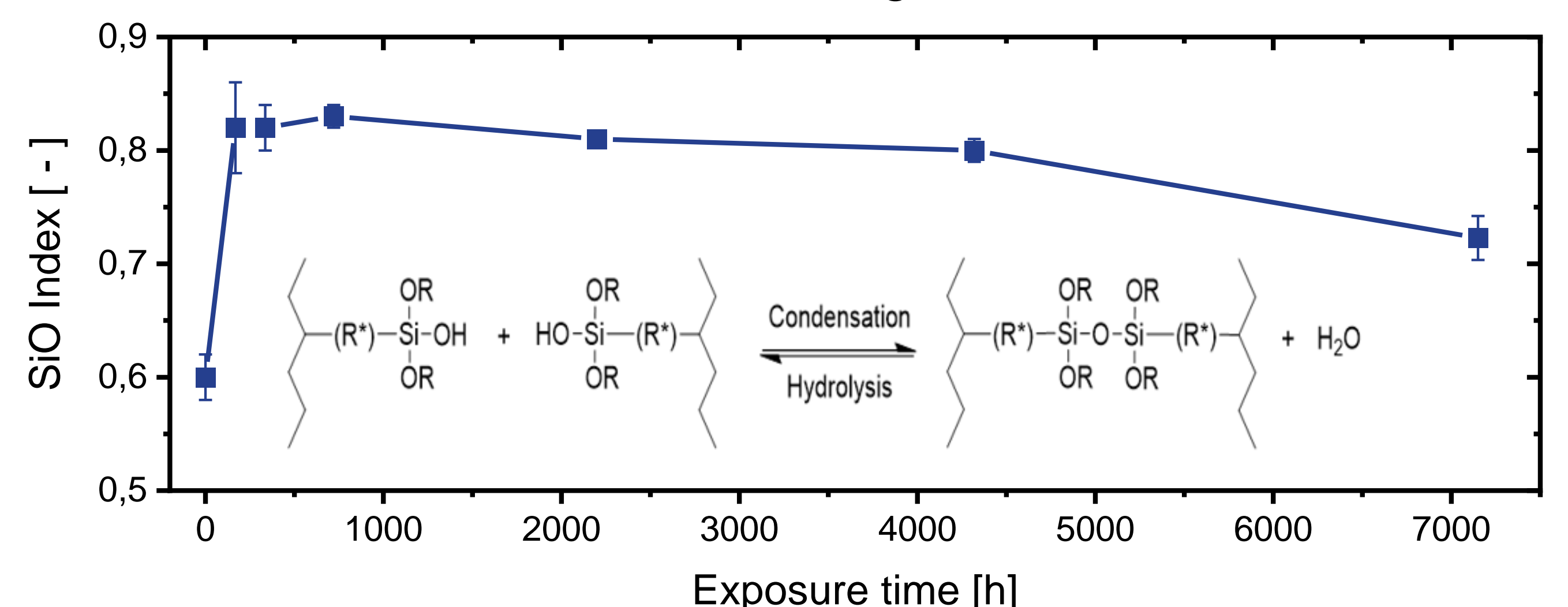
### Delamination behaviour

- Higher peel energy after short-term exposure due to cross-linking and change of failure mode:  
Adhesive / Aluminium film → PP-R liner / Adhesive
- Indications for thermo-oxidation and hydrolysis of adhesive



### Silicon-Oxide Index (SiO)

- Formation of Si-O groups after short-term exposure to hot water
- Indication for silane cross-linking



## Acknowledgement

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