Universität Rostock

Traditio et Innovatio

Membranes based on polymerized ionic liquids

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The term “ionic liquid” (IL) describes salts whose melting points are below 100 °C and which have remarkable properties as low vapor pressures. By the implementation of vinyl groups polymerized ionic liquids (PILs) are possible, which combining the advantages of solid polymeric structures and ionic liquids.[1] In membranes, these charged monomers increase the water permeability and show good anti-fouling properties.[2] Furthermore, UV initiated polymerization enables to obtain PIL membranes straight out of the casted monomer film. Besides high diversity of ILs based on the synthetic possibilities, this new approach facilitates membrane manufacturing and modification.[3]

Challenges are the optimization of long term stability of these neat, free-standing membranes and reproducibility of homogeneous pore size distributions. A high amount of free charges will be of interest to applications in waste water treatment, bio-industrial processes, ion exchange or fuel cell devices.

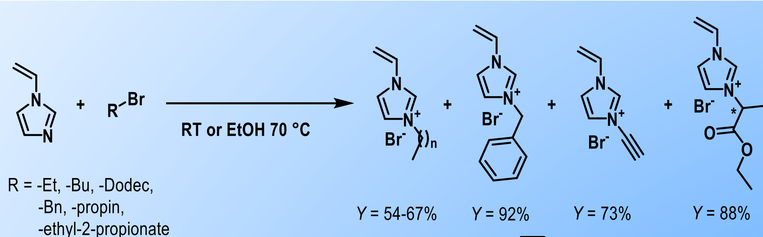


Figure 1: Schematic synthesis of different ionic liquids and their isolated yield.

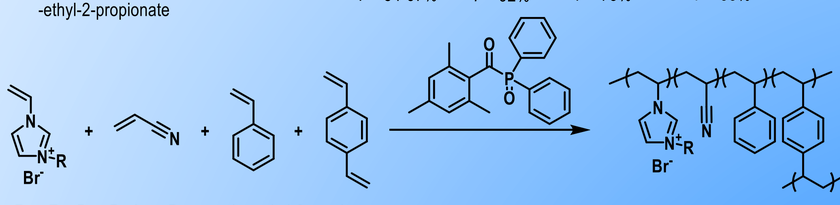


Figure 2: Schematic reaction towards the layer forming polymer.

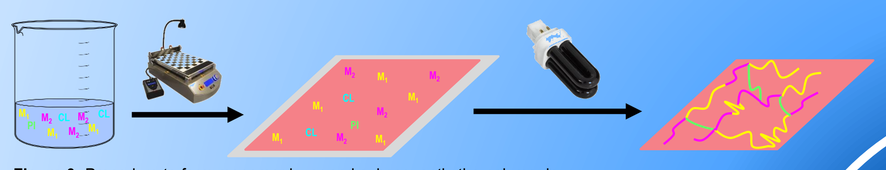
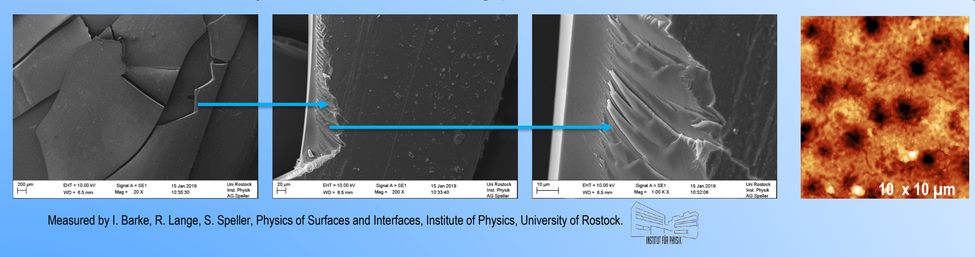
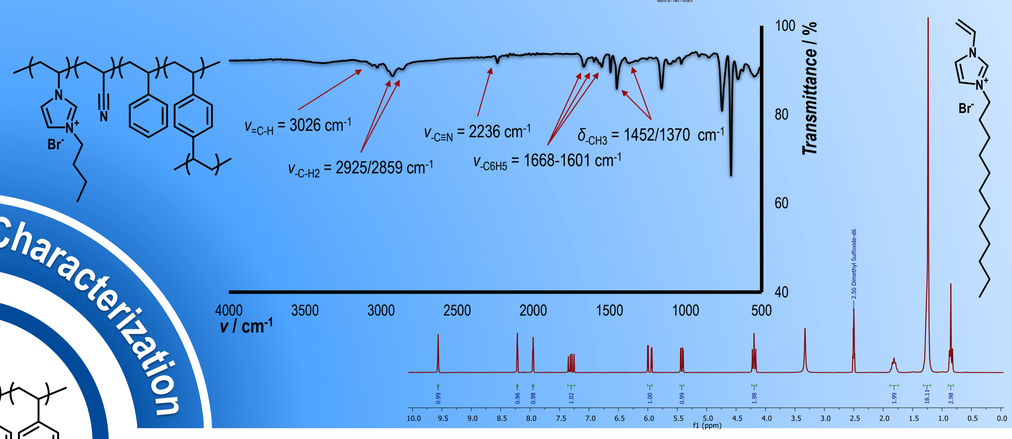


Figure 3: Procedure to form monomer layer and subsequently the polymer layer.

Conditions (Figure 1): n_{Vim}=0.2 mol, n_{Brom} = 0.225 mol, 72 h, 1 h Ar flushing, Ar atmosphere, RT (23 °C, -Et, -Bu, -Bn) or 70 °C (-Bn, -ethyl-2-propionate).
Conditions (Figure 2): n_{IL}=0.0031 mol, n_{IL} : n_{ACN} : $n_{Styrene}$ = 1 : 3 : 1, 5 wt% photoinitiator, 2 wt% crosslinker (wt% based on m_{IL}), 0.5 h ultrasonic bath, h_{gap} = 300 – 500 µm, 0.5 h Osram UV lamp, 24 h EtOH, 24 h H_2O.

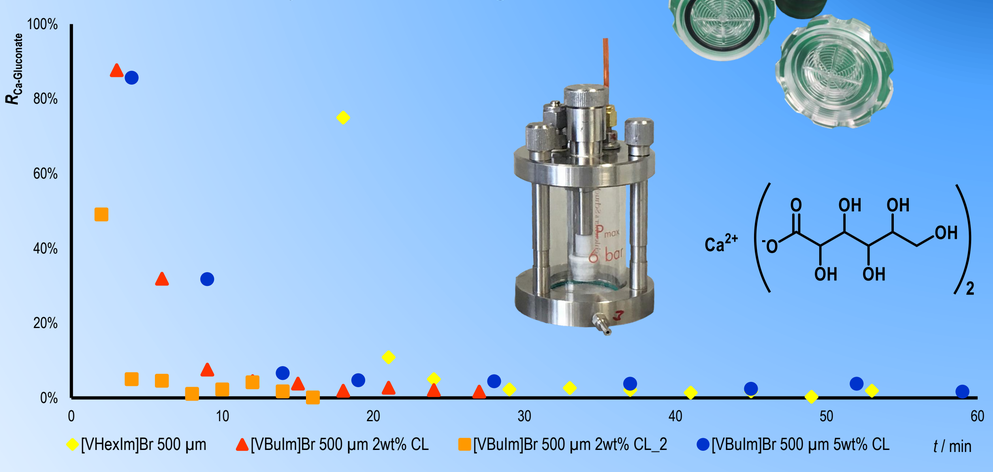
- Structure analysis of polymer layers by NMR, IR, SEM and AFM
- Further effective layer thickness, melting point of substances and mechanical stability



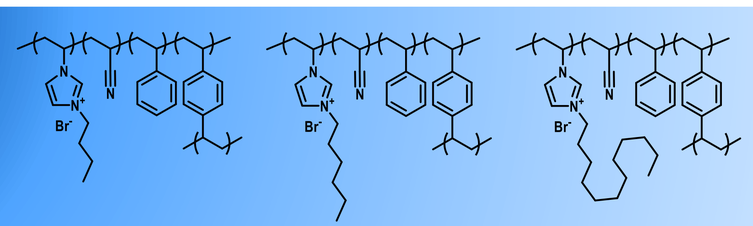


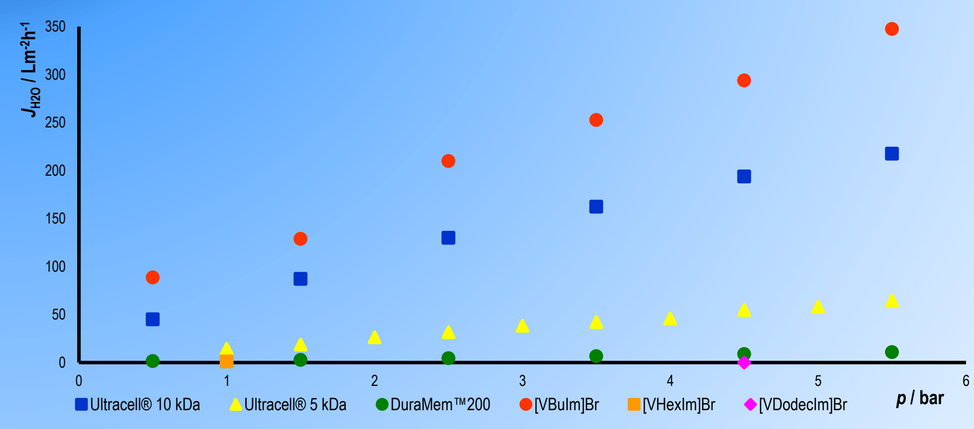
Synthesis · Characterization · Application · Water flux

- Calcium gluconate as highly charged sugar as test molecule as aqueous solution
- Retention determined by HPLC measurements of filtrate
- Decreased retention by membrane damages



Conditions: $d_{membrane}$ = 26 mm, p < 1.35 bar, $\dot{V}_{H2O}$ = 1 mL·min^{-1}, selfmade dead-end cell, n_{IL}=0.0031 mol, n_{IL} : n_{ACN} : $n_{Styrene}$ = 1 : 3 : 1, 5 wt% photoinitiator, 2 wt% crosslinker (wt% based on m_{IL}), 0.5 h ultrasonic bath, h_{gap} = 500 µm, 0.5 h Osram UV lamp, 24 h EtOH, 24 h H_2O.





Conditions: $d_{membrane}$ = 47 mm, p_{air} = 0.5 – 5.5 bar, V_{H2O} = 25 – 70 mL, Schleicher&Schuell stirred dead-end cell, n_{IL}=0.0031 mol, n_{IL} : n_{ACN} : $n_{Styrene}$ = 1 : 3 : 1, 5 wt% photoinitiator, 2 wt% crosslinker (wt% based on m_{IL}), 0.5 h ultrasonic bath, h_{gap} = 500 µm, 0.5 h Osram UV lamp, 24 h EtOH, 24 h H_2O.

- ✓ Preparation of PILs-membranes by UV polymerization
- ✓ Determination of characteristic data
- ✓ Application in permeation and separation experiments
- ❑ Disclosure of surface structure (pore size, distribution)
- ❑ Evaluating influence of monomer ratios
- ❑ Improve mechanical and long term stability

The authors like to thank the research groups of Prof. Dr. Schick and Prof. Dr. Speller for the measurements.

References:

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