Improving the mechanical properties of sulfonated polysulfones by blending with polybenzimidazole

Vladimir Atanasov, Klaus-Dieter Kreuer and Joachim Maier
Max Planck Institute for Solid State Research,
Heisenbergstraße 1, 70569 Stuttgart, Germany
e-mail: v.atanason@fkf.mpg.de

Introduction
Recently, sulfonated polysulfones with high durability, very high proton conductivity and even some methanol rejection properties have been reported [1, 2]. The advantageous properties are most pronounced for high ion exchange capacities (IEC > 2.5 meq/g) for which the highly polar character of the ionomer leads to brittleness in the dry state and low elasticity in the wet state. In an attempt to improve the mechanical and film forming properties, we have prepared blends of high IEC polysulfones (s220, IEC ~ 4.5 meq/g) and a polybenzimidazole (PBI-OO). This is expected to lead to ionic cross-links between the two polymers, which have already been proven to reduce the water uptake of similar systems [3].

Preparation

<table>
<thead>
<tr>
<th>Compound</th>
<th>Method</th>
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<tbody>
<tr>
<td>PBI-OO</td>
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<tr>
<td>s220</td>
<td></td>
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Filtration:
20 2400
4 200
2.9 50
60 3.5 80
180 60
0 12
3.2 300
100 200
70 40
300 140
100 70

Indirect titration (exchange of the membrane protons with NaOH solution and titration of the formed HCI with NaOD)

Method of measuring: Indirect titration (exchange of the membrane protons with NaOH solution and titration of the formed HCl with NaOD).

Possible reasons for the observed lower IEC:
- Inaccessibility of the sulfonic function in the PBI-OO matrix;
- incomplete cleavage of the EtNH group;
- loss of the sulfonic function due to condensation reaction.

Reflux of the blends in water

<table>
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<tr>
<td>s220</td>
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Dynamic Scanning Calorimetry

Conductivity

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<th>Method</th>
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DSC did not indicate any phase transition below 300°C.

Conductivity measurements were performed in a closed cell on a stack of membrane disks with a 4 and total thickness of 1.5 mm. The water content is calculated after the measurement and is presented here as λ=[H]/[SO₄²⁻].

Possible reasons:
- strong multicentre intermolecular interaction;
- hydrophilicity of PBI-OO.

Water uptake

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The decrease of the water uptake with temperature could be attributed to extraction of s220 from the blends. This is supported by the fact that decrease of λ is higher for blends with higher s220 content.

Possible reasons:
- strong multicentre intermolecular interaction;
- hydrophilicity of PBI-OO.

Conclusions & Outlook

Blending high conductive s220 with PBI-OO, which brings the softness and stabilizes the blends through acid-base interactions, gave us access to a membrane with improved mechanical toughness. Although, these are very preliminary results, this material combines high thermal and mechanical stability with high conductivity at relatively high water content. In order to prove and explain the properties of these membranes, a detailed investigation on the local microstructure and domain dimensions is in progress.

Literature


Acknowledgements

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