

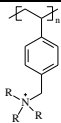
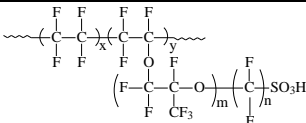
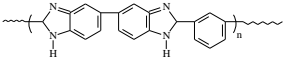
Supplementary Information

1. Ethanol oxidation reaction in alkaline media:

On the anode, ethanol, being mixed with an alkali, is oxidized to form acetic acid (CH₃COOH) according to:



2. The chemical structures of the three membranes:

Membrane type	Anion-exchange membrane (AEM)	Cation-exchange membrane (CEM)	Polybenzimidazole (PBI)
Structure [2, 3]			

3. The charge transfer mechanisms through the three membranes:

	AEM	CEM	PBI
In water [4]	Functional groups	Functional groups	Ion isolator
In alkaline solution [5]	Functional groups + Alkali-doped free volumes	Functional groups + Alkali-doped free volumes	Alkali-doped free volumes

References:

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- 2** G. Couture, A. Alaaeddine, F. Boschet, B. Ameduri, *Progress in Polymer Science* 2011, **36**, 1521-1557.
- 3** J.R. Varcoe, R.C.T. Slade, *Fuel Cells* 2005, **5**, 187-200.
- 4** G. Merle, M. Wessling, K. Nijmeijer, *J. Membr. Sci.* 2011, **377**, 1-35.
- 5** Z. Mai, H. Zhang, X. Li, X. Geng, H. Zhang, *Electrochem. Commun.* 2011, **13**, 1009-1012.