Comparative Study of the Properties and Degradation of Sulfonated Poly(arylene ether sulfone)s with the Same Polymer Backbone but with Different Positions of the Acid Groups

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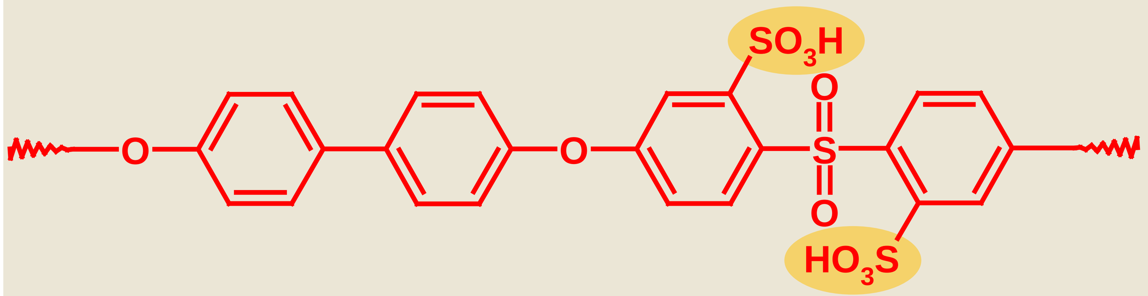
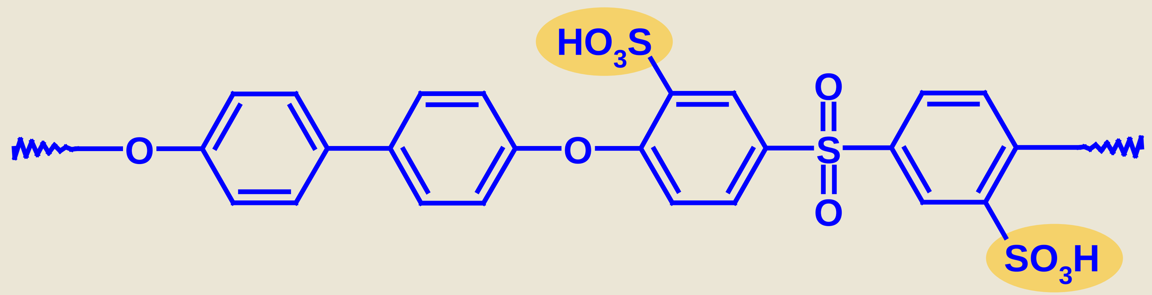
OBJECTIVE

Sulfonated poly(arylene ether sulfone)s (SPAESs) are considered as one promising candidate to replace perfluorosulfonic acid polymers (PFSAs). Especially their excellent mechanical modulus and high gas barrier properties can simplify the fuel cell systems by operating at higher temperatures and with a thinner membrane thickness than that of PFSAs. However, the main drawbacks are the poor proton conductivity at sub-zero temperatures and risk for desulfonation. In the present work, therefore, SPAESs with several different positions of the acid groups were prepared and investigated at a given ion-exchange capacity (IEC) for both membrane performances and stabilities.



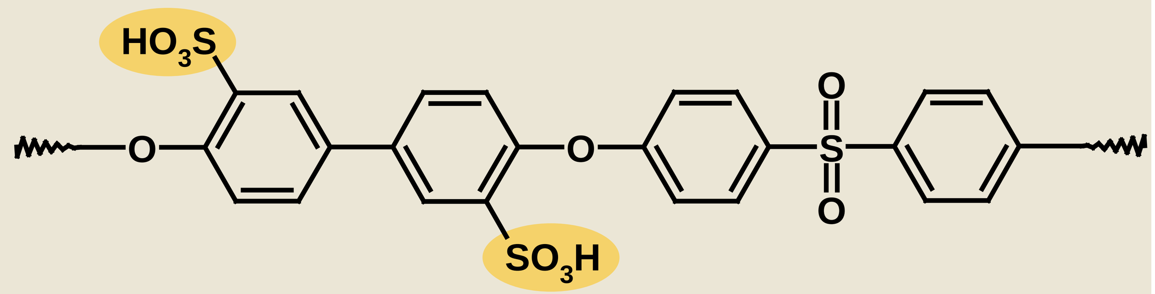
os*SPAES** (o**rtho*-positions to **s**ulfone bridges)

Titrated IEC (meq./g): 1.44, 1.88



ms*SPAES** (m**eta*-positions to **s**ulfone bridges)

Titrated IEC (meq./g): 1.59, 2.16



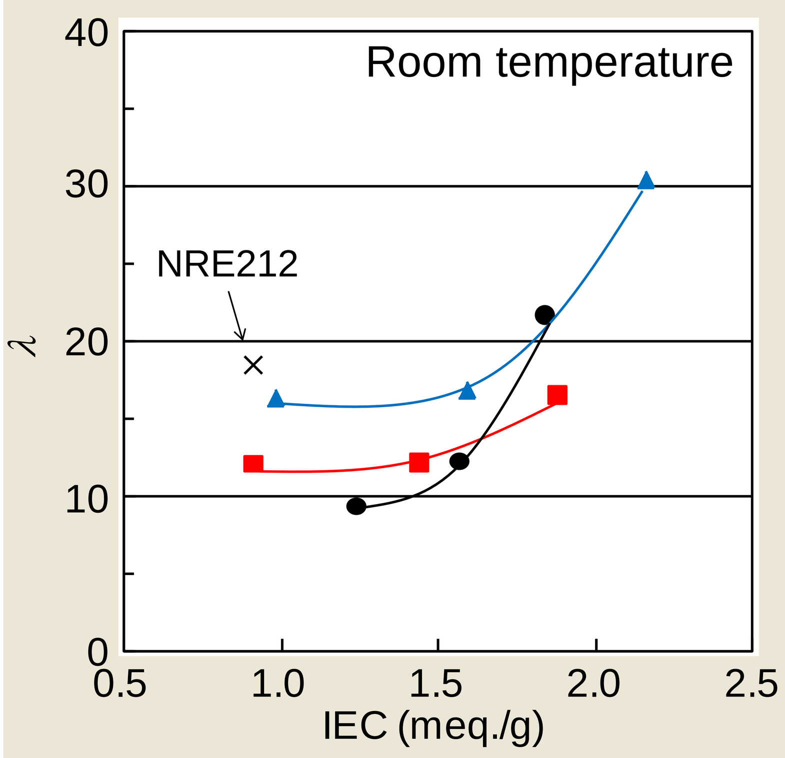
oe*SPAES** (o**rtho*-positions to **e**ther bridges)

Titrated IEC (meq./g): 1.57, 1.84

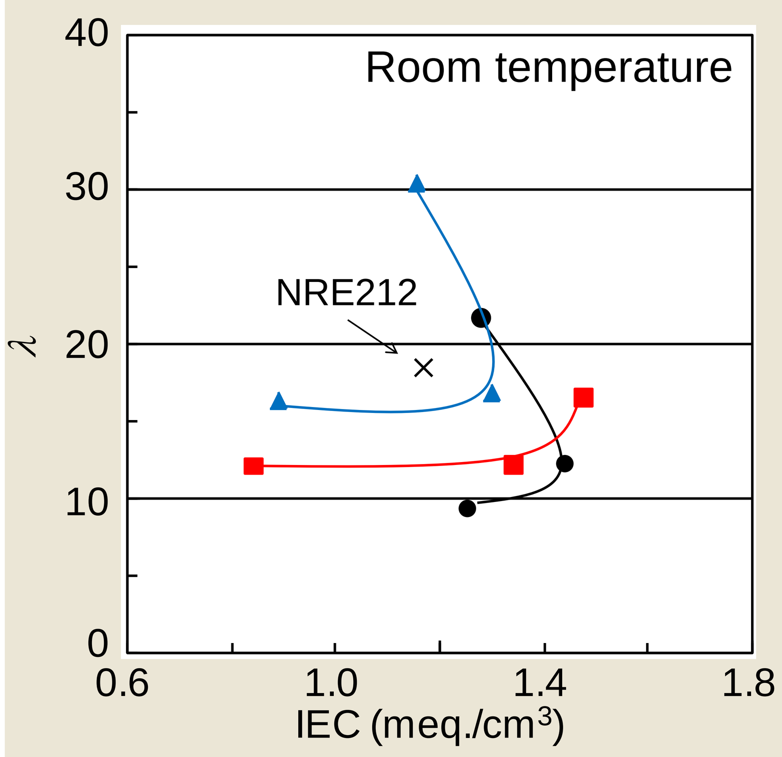
PERFORMANCE

Water uptake

➢ mass-based IEC

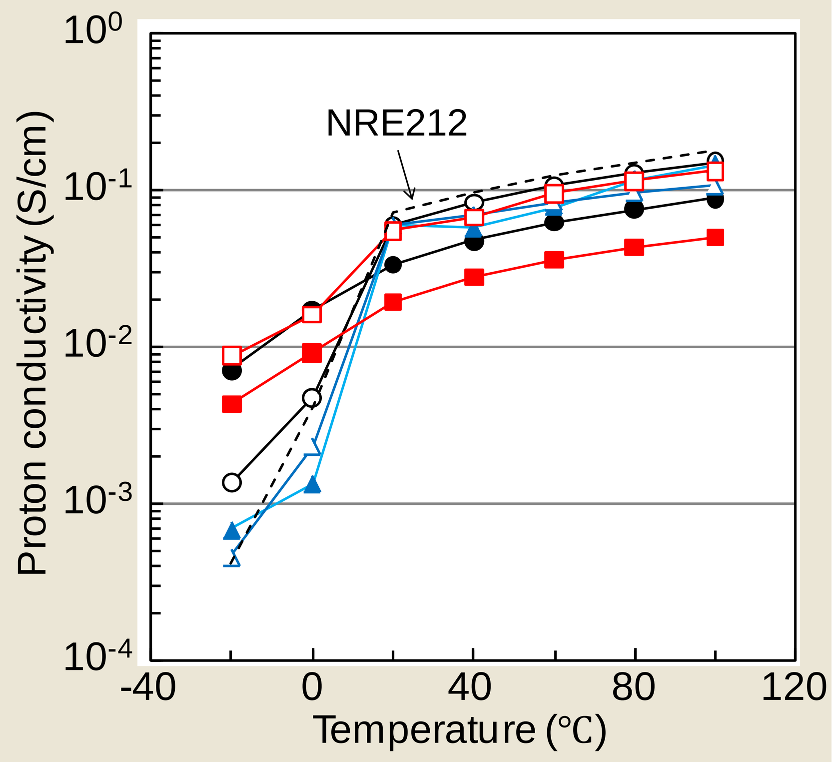


➢ volume-based IEC

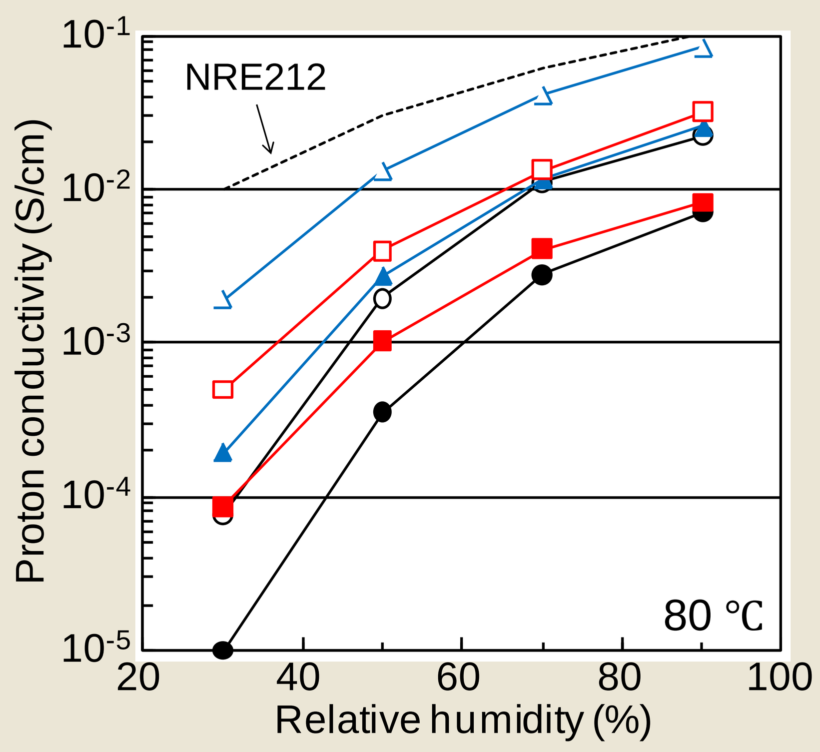


Proton conductivity

➢ fully hydrated condition



➢ humidity dependence

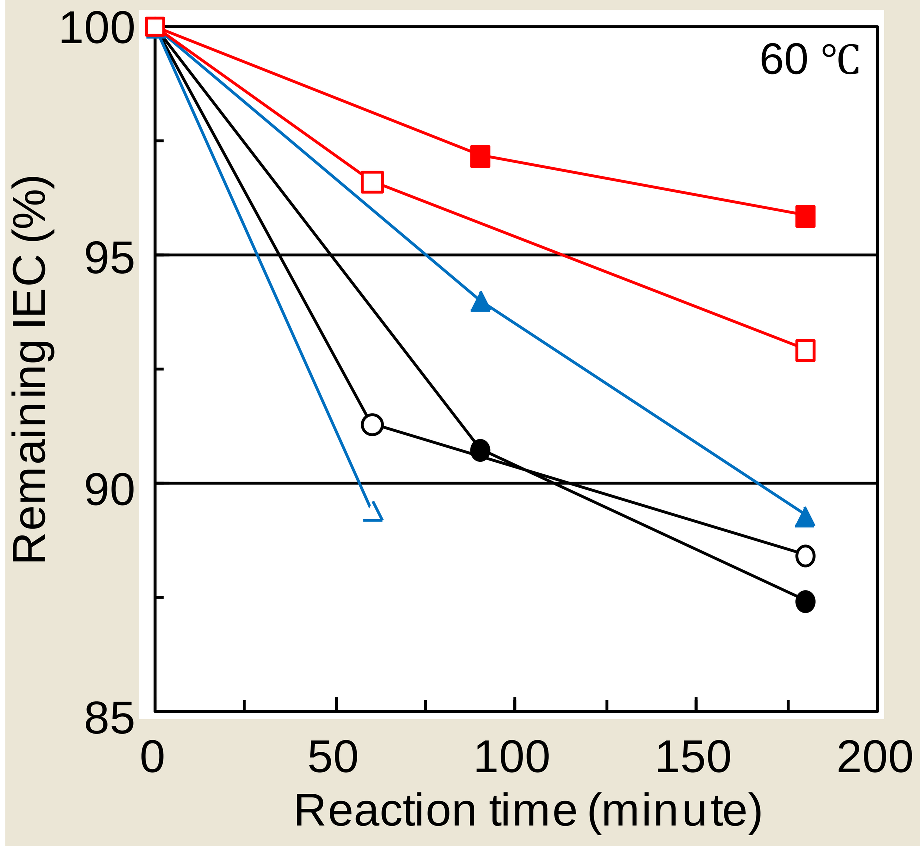


Further details are found at:
S. Takamuku, P. Jannasch, *Polym. Chem.* **2012**, *3*, 1202-1214

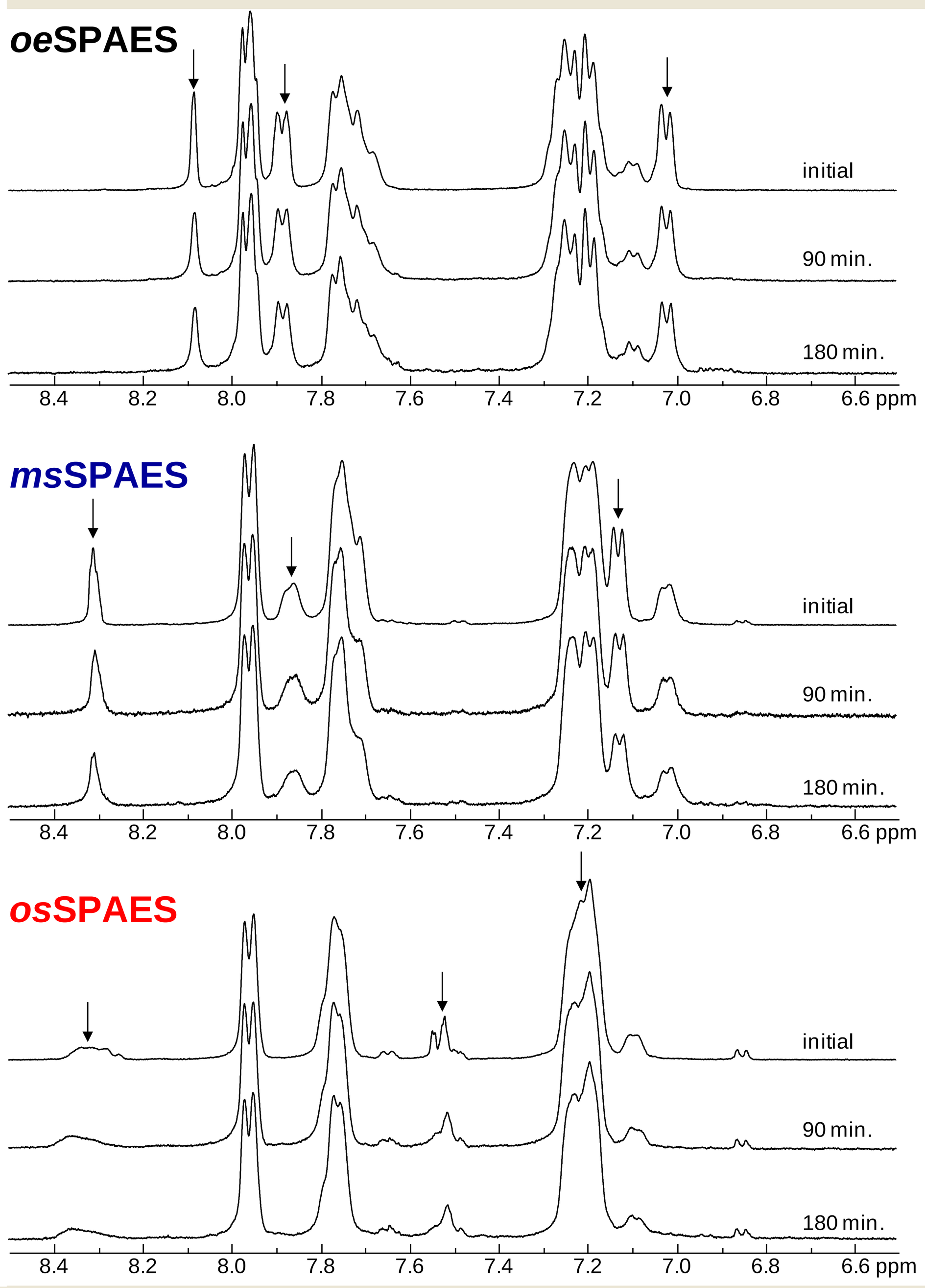
CHEMICAL STABILITY

Fenton test

➢ 3.5% H_2O_2 aq., 3 ppm Fe^{2+}

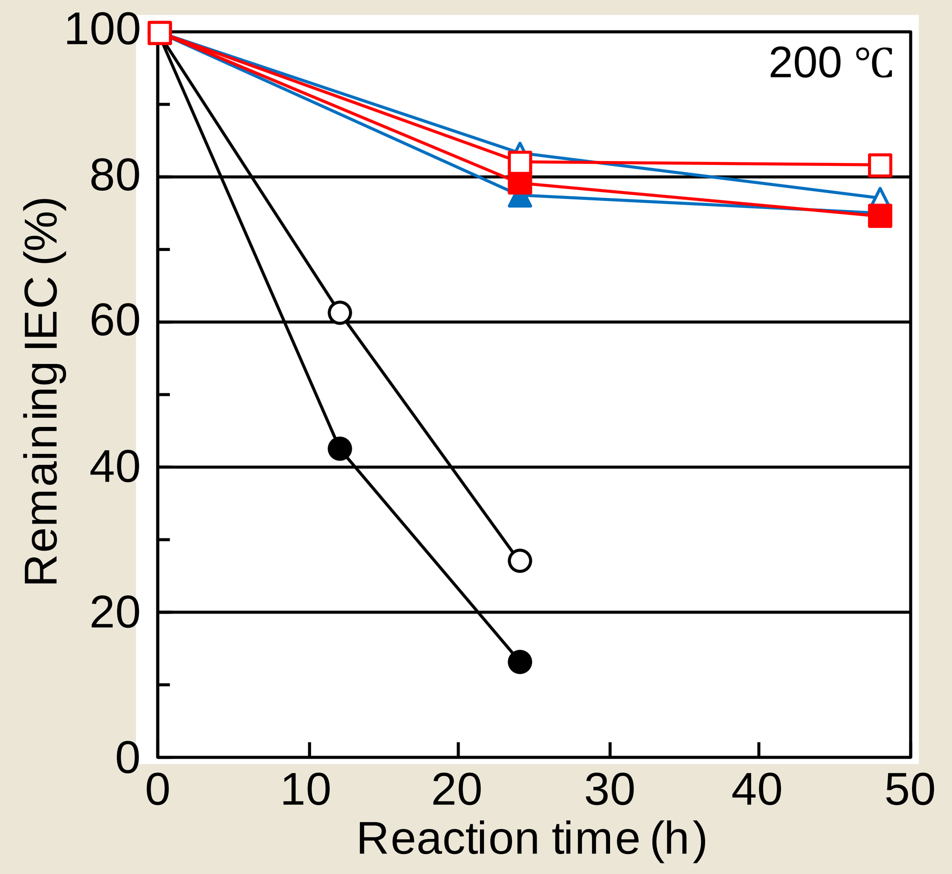


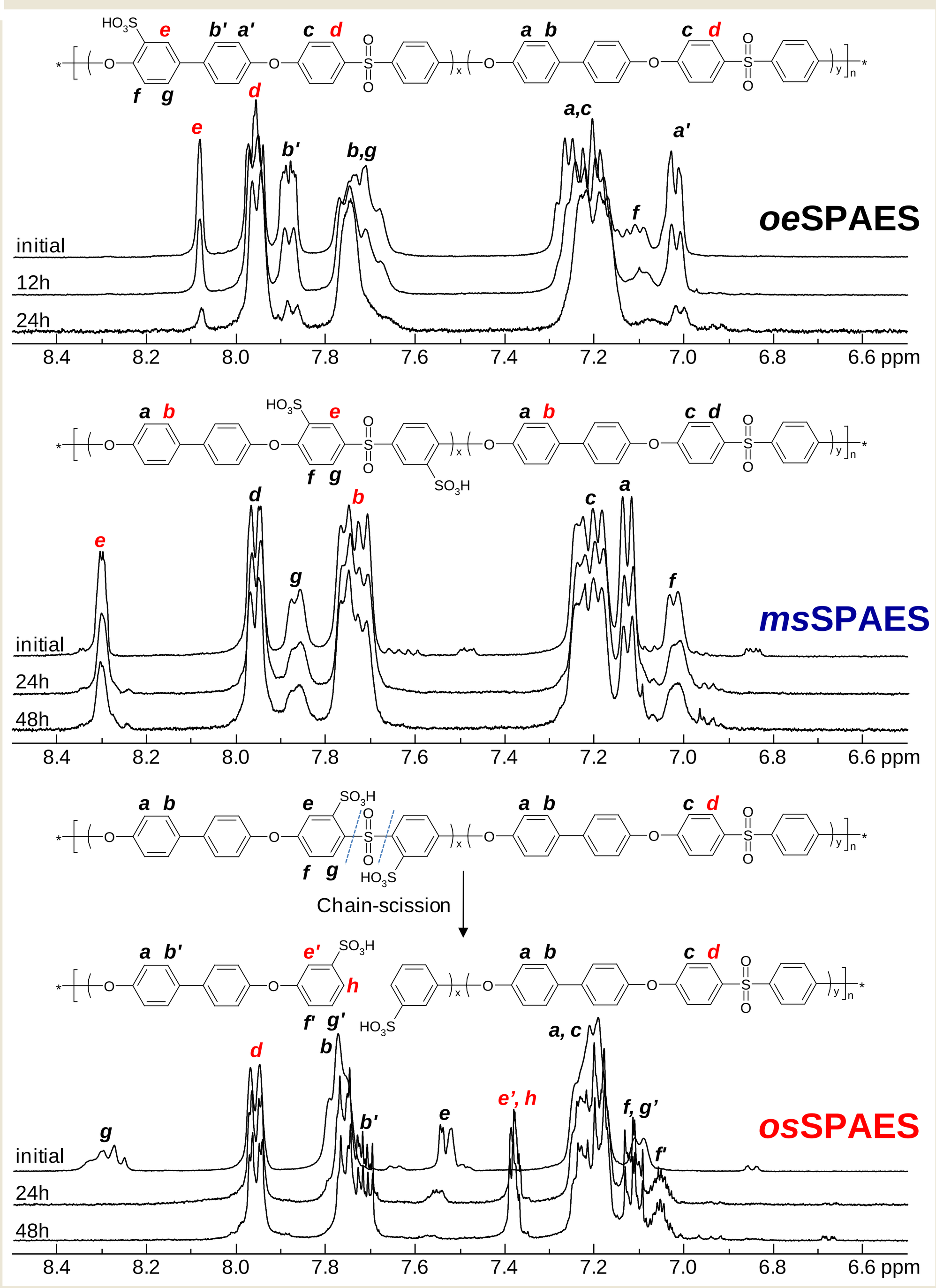
➢ ^1H NMR analysis (DMSO-d_6)



Hydrolysis test

➢ 0.1 M HCl aq., sealed





ACKNOWLEDGEMENT

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CONCLUSIONS

Three types of SPAESs, despite the same polymer backbone, provided remarkably different properties at a given IEC.

	Water uptake	Conductivity at subzero temp	Radical resistance	Hydrolytical resistance
***os*SPAES**	Low	High	High	High
***ms*SPAES**	High	Low	Low	High
***oe*SPAES**	Low	Low	Low	Low