Grafting of Styrene onto Plasma-Activated Polypropylene

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Motivation

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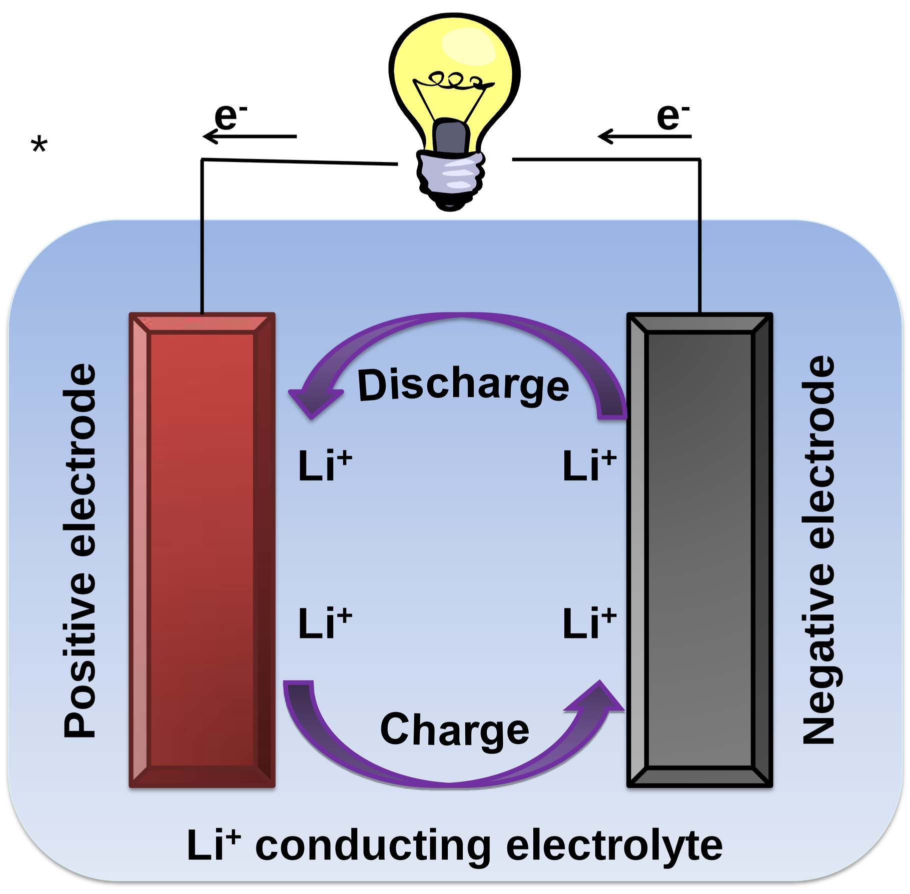


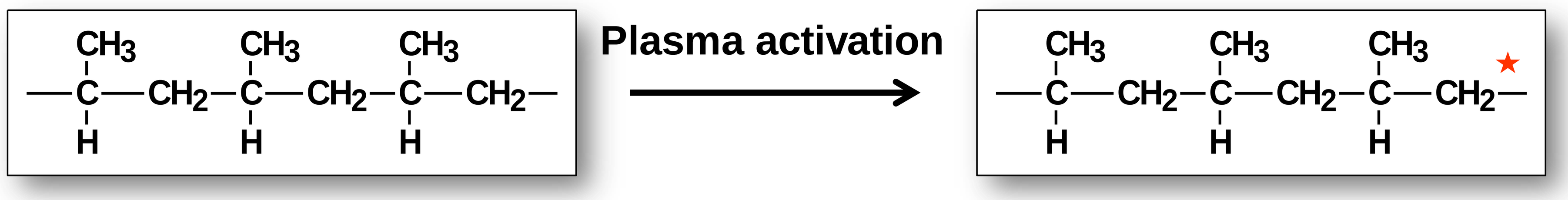
Lithium – sulphur battery

Key issues

- ❑ Polymer separator architecture
- ❑ Improved cycling behaviour [1]
- ❑ Minimised polysulphide shuttle [1]

* Adapted from Accounts of Chemical Research 46 (2013) 1135 – 1143

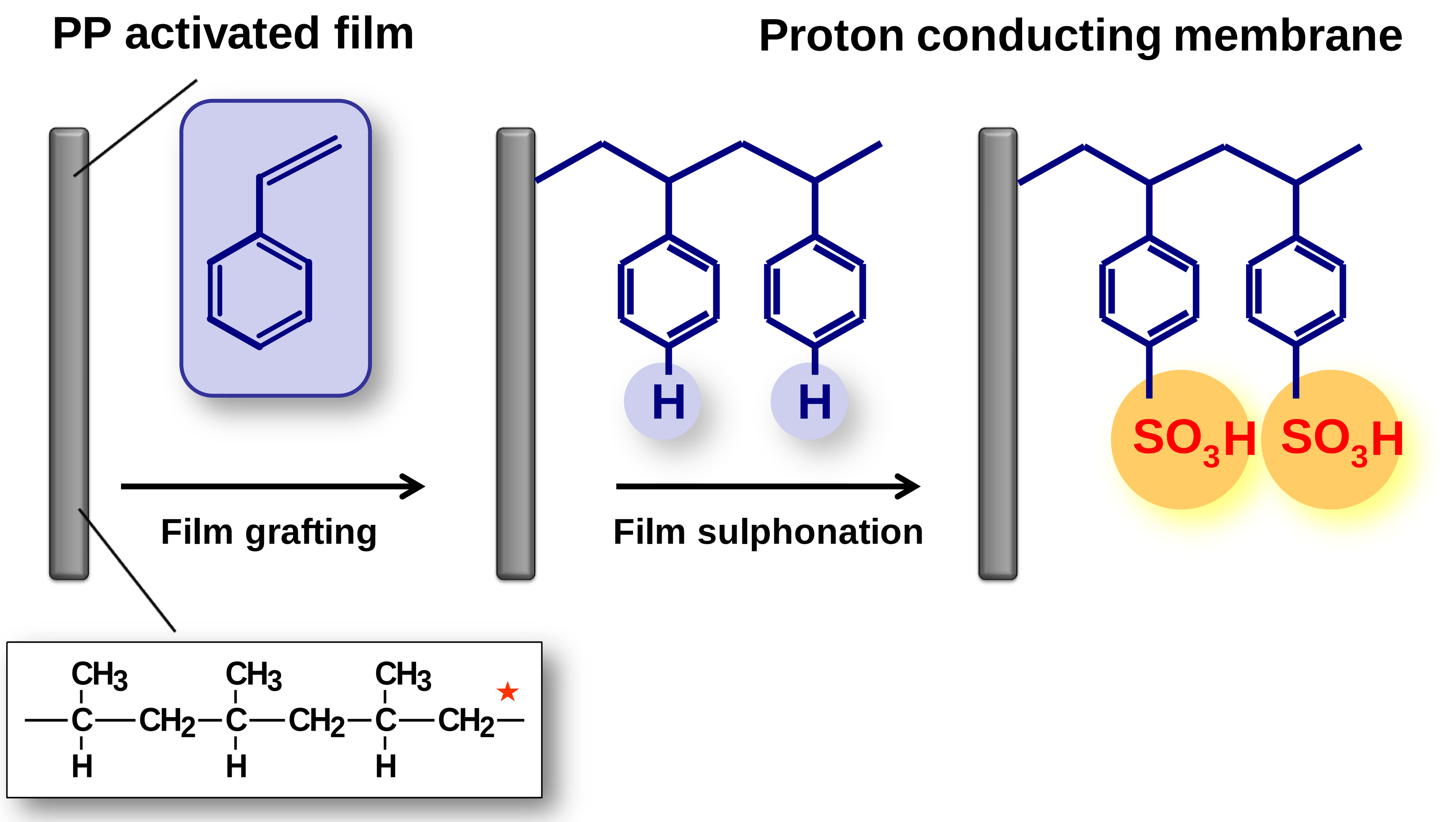
The Advantages of Plasma Activation



Plasma-induced graft polymerisation…:

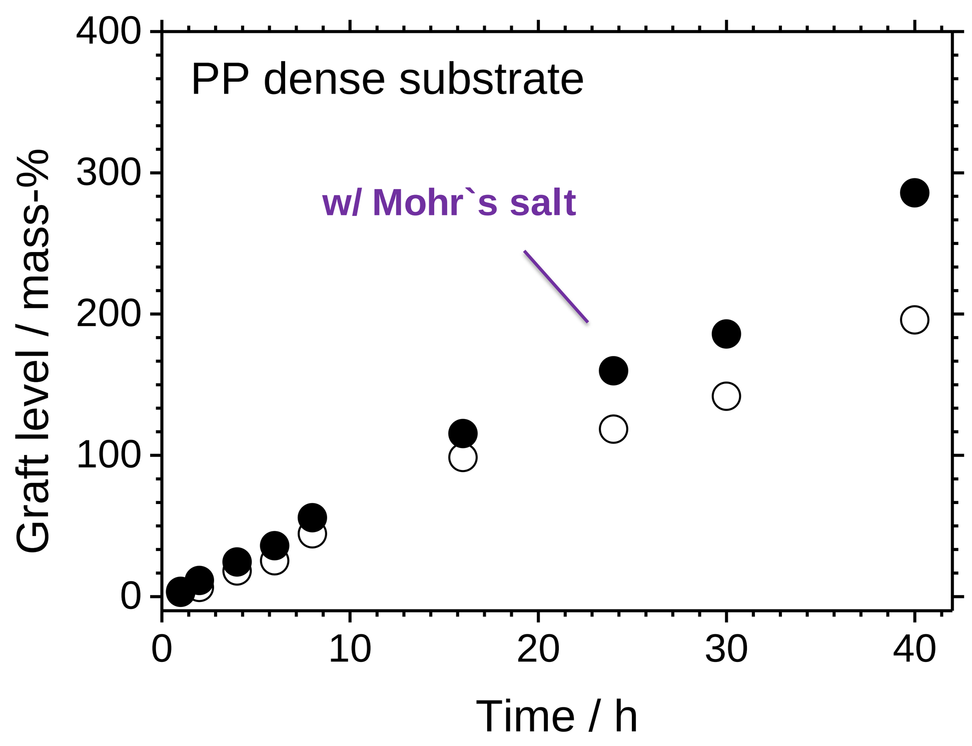
- ❑ … can activate only the surface-near regions (100 Å) [2]
- ❑ … can introduce favourable features into the material [3]
- ❑ … does not strongly affect the mechanical properties of the material [2]

The Preparation of Styrene Based Membranes

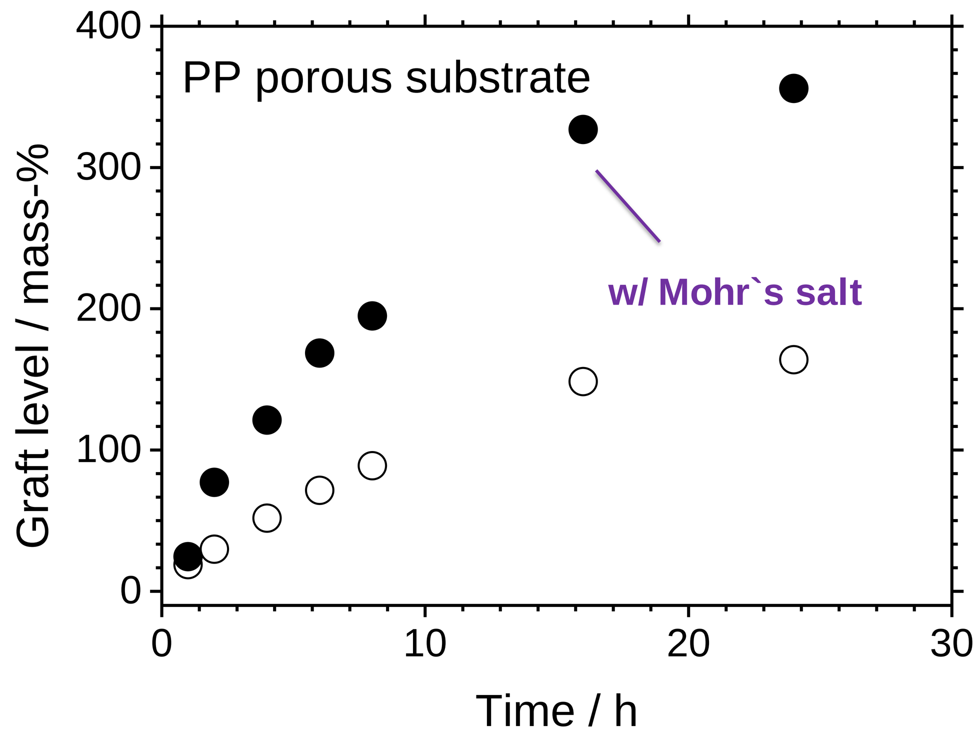


Film type:	(1) Porous substrate (15µm, Treo-Pore, model system)
	(2) Dense substrate (15µm, Goodfellow, for comparison)
Film activation:	(1) Plasma activation (30 W, 5 min each side)
	(2) Electron-beam irradiation (15 kGy)
Film grafting:	Styrene (20 v-%), iPrOH (70 v-%), H_2O (10 v-%), @ 60ºC
Film sulphonation:	2% $ClSO_3H$ in $CHCl_2$ @ RT followed by hydrolysis @ 80ºC for 8h

Grafting Kinetics of PP-g-Styrene



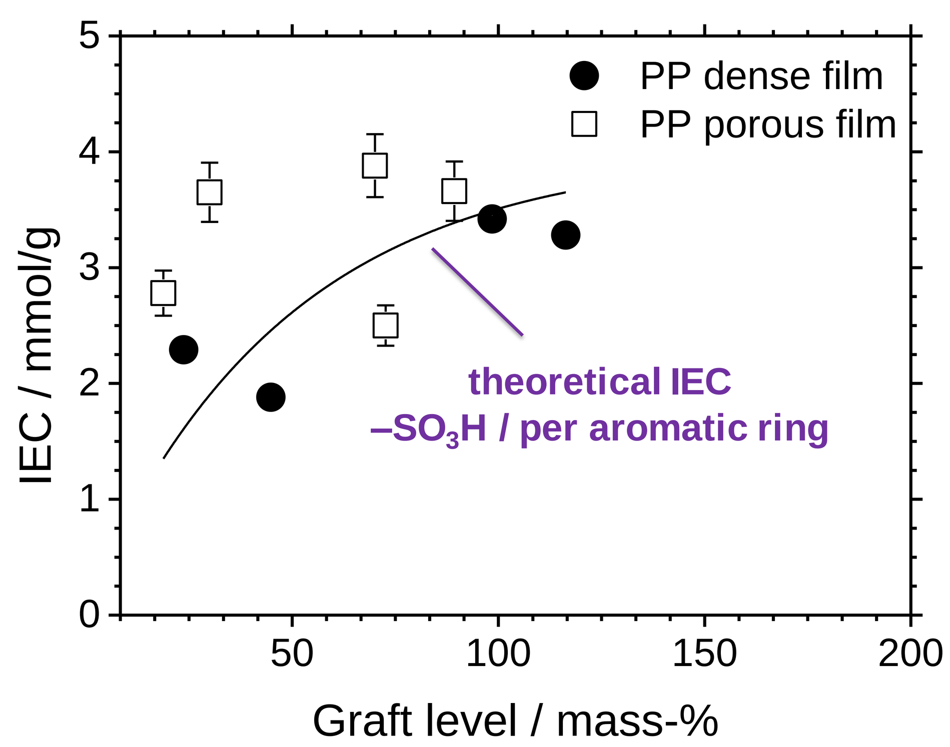
Grafting in bulk
↓
Diffusion limitations
Constant grafting rate



Grafting at the surface
Grafting rate decreases with time

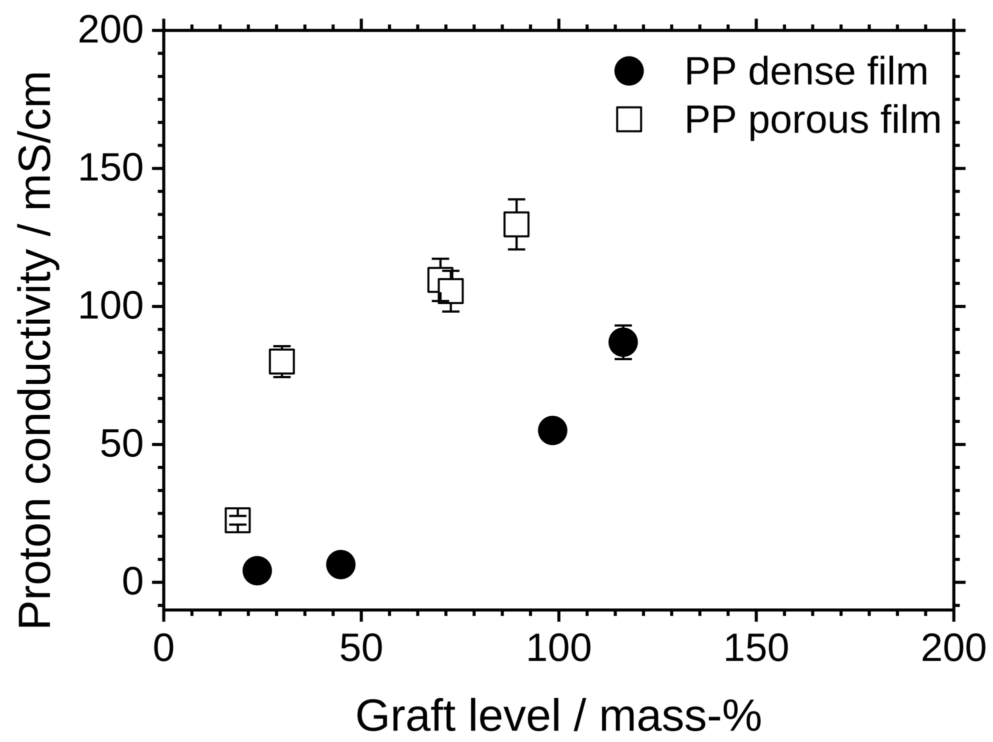
The addition of $(NH_4)_2Fe(SO_4)_2{\cdot}6H_2O$ (Mohr's salt) → increased grafting yield [4]

Characterisation of Grafted Membranes



Porous PP: higher IEC trend attributed to the sulphonation of a small fraction of PP

Porous PP: higher conductivity due to better access of H^+ in the open structure



Conclusions

- ❑ Highly grafted PP porous membranes in a shorter reaction time
- ❑ Good proton conducting membranes based on PP porous substrate
- ❑ Enhanced grafting kinetics due to the addition of homopolymer inhibitor

References:
[1] S. S. Zhang, *Journal of Power Sources* 231 (2013) 153 – 162
[2] T. Desmet, R. Morent, N. De Geyter, C. Leys, E. Schacht, P. Dubruel, *Biomacromolecules* 10 (2009) 2351 – 2378
[3] X. Chi, H. Ohashi, T. Tamaki, T. Yamaguchi, *Journal of Photopolymer Science and Technology* 24 (2011) 471 – 473
[4] M.M. Nasef, E.S.A. Hegazy, *Progress in Polymer Science* 29 (2004) 499 – 561

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