Perfluoropolyethers as hydrophobizing agents for Fuel Cells Gas Diffusion Layer

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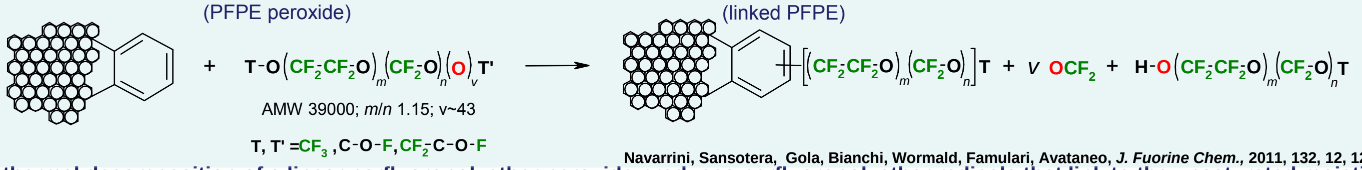


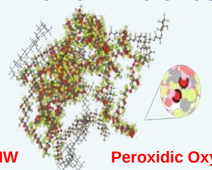
Navarrini, Sansotera, Gola, Bianchi, Wormald, Famulari, Avataneo, *J. Fuorine Chem.*, 2011, 132, 12, 1254-1261

The thermal decomposition of a linear perfluoropolyether peroxide produces perfluoropolyether radicals that link to the unsaturated moieties of carbonaceous materials. The decomposition occurs between 110-200°C and generates radical species with half-life time of 30 mins.

CARBON BLACK

VULCAN XC72R

Z-Fomblin® Peroxide

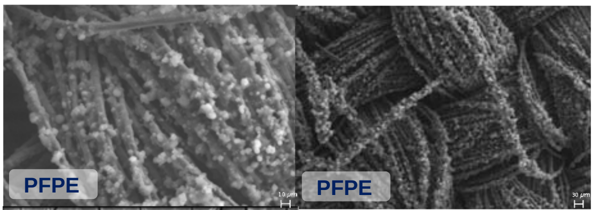


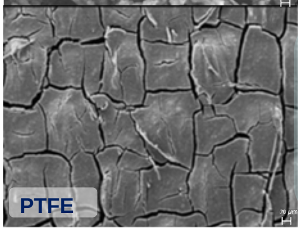
AMW ~39000 u
C_2/C_1 ratio 1.15
Peroxidic Oxygen $1.33\%_{wt}$
Equivalent Weight ~1200 u

CARBON CLOTH

SEAL SGCC5N

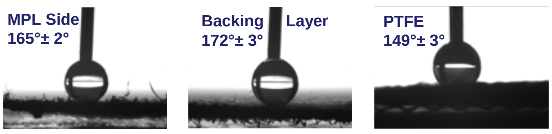
A ink for microporous layer (MPL) was prepared by dispersing carbon black and perfluoropolyether peroxide (1:1 ratio) in a perfluorinated solvent. The ink was deposited on carbon cloth by spray deposition method.
The peroxide was decomposed between 110-200°C under nitrogen. The fraction of PFPE that did not linked the carbonaceous matrix was removed by washings with perfluorinated solvent. Thereafter, the sample was dipped in a 2% solution of PFPE peroxide and, then, treated between 110-200°C under nitrogen in order to obtain a uniform hydrophobization of the carbon cloth.
$10\%_{wt}$ PFPE was linked to the carbon black for MPL and $1\%_{wt}$ PFPE was linked to the carbon cloth backing layer.

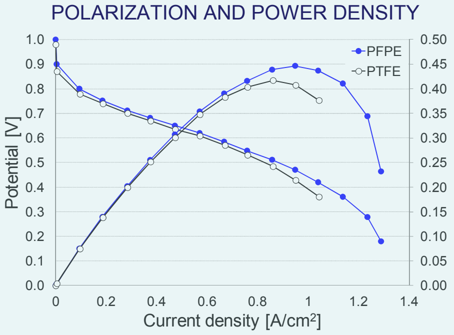


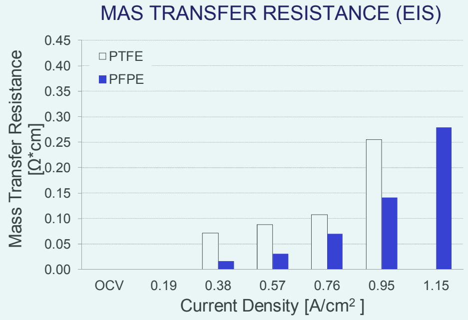


XPS - Elemental Composition

	MPL Side ($at_{\%}$)	Backing Layer ($at_{\%}$)
F	44%	55%
O	15%	22%
C	41%	23%







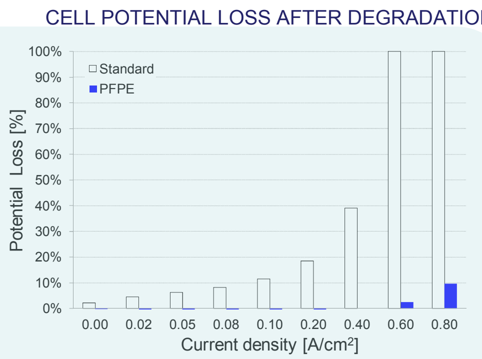
Gola, Sansotera, Navarrini, Bianchi, Dotelli, Latorrata, Gallo Stampino, *J. Power Sources*, 2014, 258, 351-355

The PFPE GDL was tested in a Polymeric Electrolyte Membrane Fuel Cell (PEMFC) and the results were compared to a standard PTFE-hydrophobized GDL ($10\%_{wt}$ PTFE). PFPE functionalized GDL increase the cell performances by largely decreasing the mass transport resistance due to improved water management.

PFPE functionalization was tested in the PEMFC catalyst layer to prevent electrochemical degradation of materials of the carbon black supporting material.
The functionalized material and a standard non functionalized material were subjected to an accelerated degradation. Results obtained by comparing cell performances before and after the degradation revealed that PFPE functionalization highly decreases the degradation effect.

ACCELERATED DEGRADATION TESTING

Step	Test type	Sweep rate (mV/s)	Description
0	Conditioning by cycling between 0.05 and 0.9 V 3 hours with 50 mV sec⁻¹		Conditioning
1	Polarization curve		Test before accelerated degradation
2	Accelerated degradation	1 mV/s	1 V --> 1,6 V 10 cycles
3	Polarization curve		Test after accelerated degradation



Conclusions

PFPE chains were covalently linked to carbon black and carbon cloth in order to obtain superhydrophobic carbonaceous functional materials. The PFPE-modified carbon-based materials were tested as a Gas Diffusion Layers (GDL) in a PEMFC. Polarization curves and impedance spectroscopy showed that PFPE-functionalized materials provided better performances than PTFE-hydrophobized standards, thanks to an improved water management.
The PFPE functionalization of carbon black was also applied in in catalyst layer, decreasing the electrochemical degradation of the material