Methods for HT-PEM FC electrodes preparation

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Methods for HT-PEMFC electrode preparation and their influence on MEA activity

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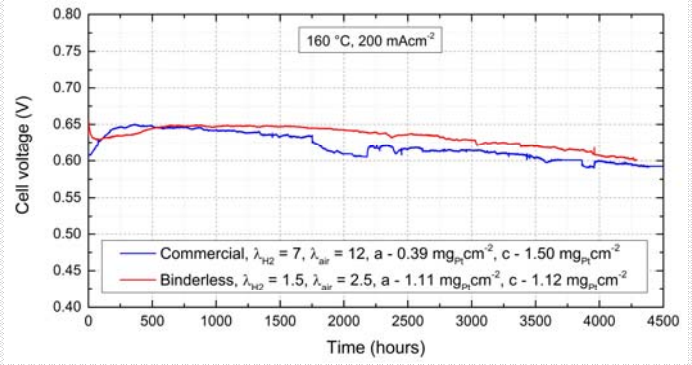
Catalyst layers made by spraying or tape casting have been prepared and evaluated on the cathode side of an HT-PEMFC. For spraying the catalyst inks were prepared by ultrasonic treatment and for tape casting the slurries were prepared by planetary milling. Different solvents and various amounts of binder have been tried to find optimum compositions. Additions of more than 20 wt% binder content greatly improves handling of the electrodes without sacrificing MEA performance.

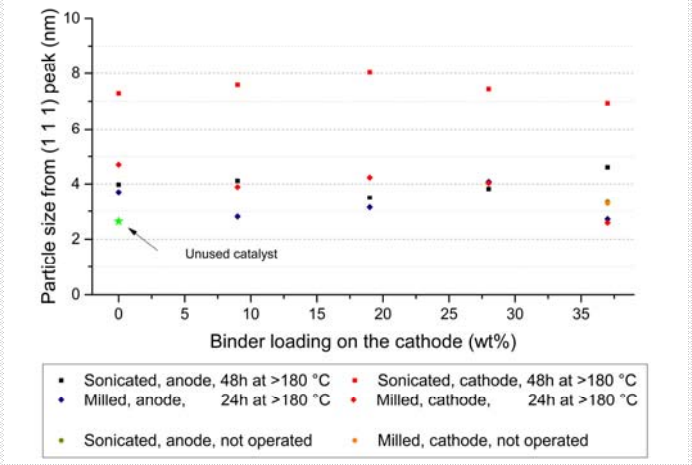
Recently it has been shown that a MEA with catalyst layers made from an ink containing only the Pt/C catalyst in ethanol exhibits similar performance with a MEA prepared by standard methods [1].

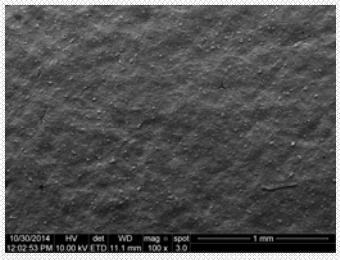


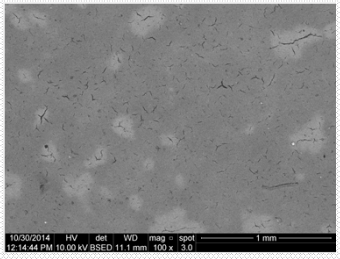
To obtain better handling of the final electrodes and improve the porosity a binder with decomposition temperature suitable for *in-situ* removal was chosen. Several solvents have been tried to find an optimum ink formulation and 2-butanone proved to be the best candidate. Ink formulations were made with ultrasonic treatment or by planetary milling. Spraying and tape casting were investigated as catalyst deposition methods.

Solvent	Ethanol	Acetone	2-butanone	1-propanol	2-propanol
Binder	Not dissolved	Dissolved	Dissolved	Not measured	Not measured
Catalyst	Combustion	No reaction	No reaction	Peroxide formation	Peroxide formation

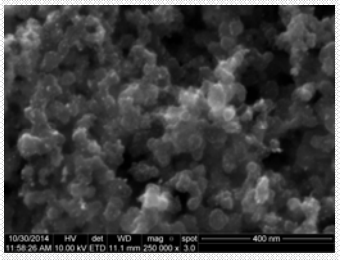
Particle size analysis show no significant influence of preparation methods on the growth of Pt catalyst particles. Prolonged operation at elevated temperature showed a stronger effect for the cathode catalyst.



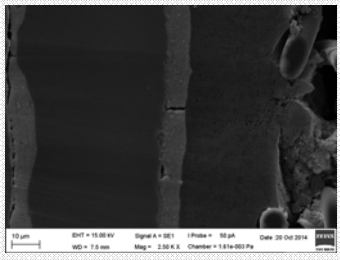




Secondary and backscattered electron images of a tape cast electrode with Pt/C catalyst and 28 wt% binder content. The structure of sprayed electrodes is comparable (not shown). Cracks appearing with increasing binder content is similar to conventional PBI-containing electrodes [2].

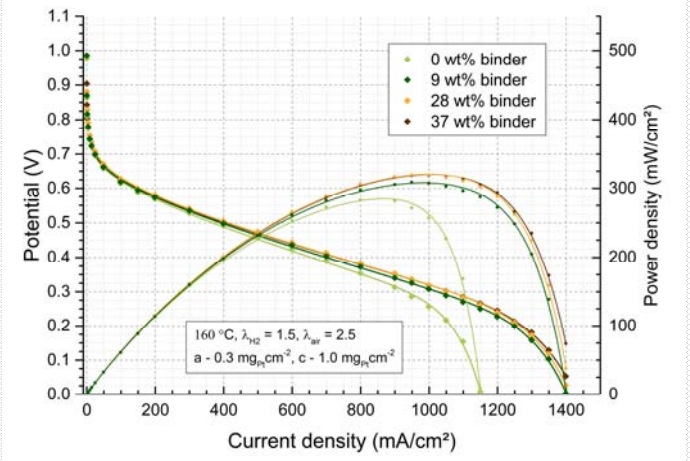


SEM picture of an electrode with Pt/C and 28 wt% binder content. The individual Pt particles are not covered with the binder.



Cross section image of a MEA with Pt/C and 28 wt% binder content on the cathode (center) and commercial anode (left). Electrode structures are comparable.

Polarisation and power curves of MEAs with increasing binder content on the cathode side show a positive effect on the cell performance in high current density range. This can be due to increased triple phase boundary obtained by removal of the binder.



[1] S. Martin, Q. Li, T. Steenberg and J.O. Jensen, *Binderless Electrodes for High-Temperature Polymer Electrolyte Membrane Fuel Cells*, Journal of Power Sources, 2014, 272, p. 559.

[2] J. Lobato et al., *Study of the influence of the amount of PBI–H_3PO_4 in the catalytic layer of a high temperature PEMFC*, Int. Journal of Hydrogen Energy, 2010, 35, p. 1347.