Influence of support morphology on MEA performance using carbonized PANI as alternative support material

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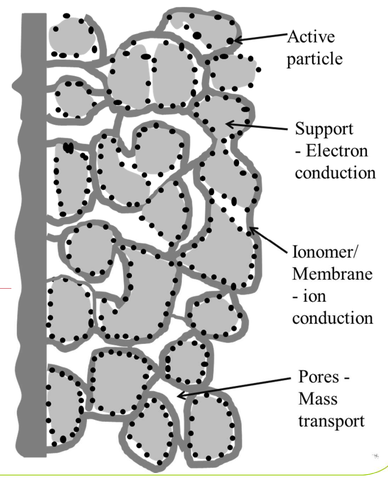
Erneuerbare Energien

Introduction

The electrode morphology is crucial for the performance of PEMFC [1]. Structuring of the electrode can be done using PANI materials, which can be carbonized to N-doped carbon material with good long term stability during carbonization [2].
In this work we show how the morphology of the electrode can be influenced by different chemical synthesis of the PANI precursor.



Synthesis and electrode preparation

- Three PANI precursors were synthesized by wet chemical procedure using aniline and APS in stoichiometric ratio in different reaction media, (1M H_2SO_4, 0,1M H_2SO_4 or 0,4 M HAc).
- PANI was decorated with Pt usingH_2PtCL_6 and HCOOH as reduction agent.
- Carbonization was conducted under nitrogen flow at T = 750 °C (heating rate: 1 °C/min, 90 min).
- Electrodes were produced using a layer by layer technique derived fast spraying technique [3] with 200 mg of as prepared catalyst and Nafion® in two separate inks.

Fuel Cell Measurements

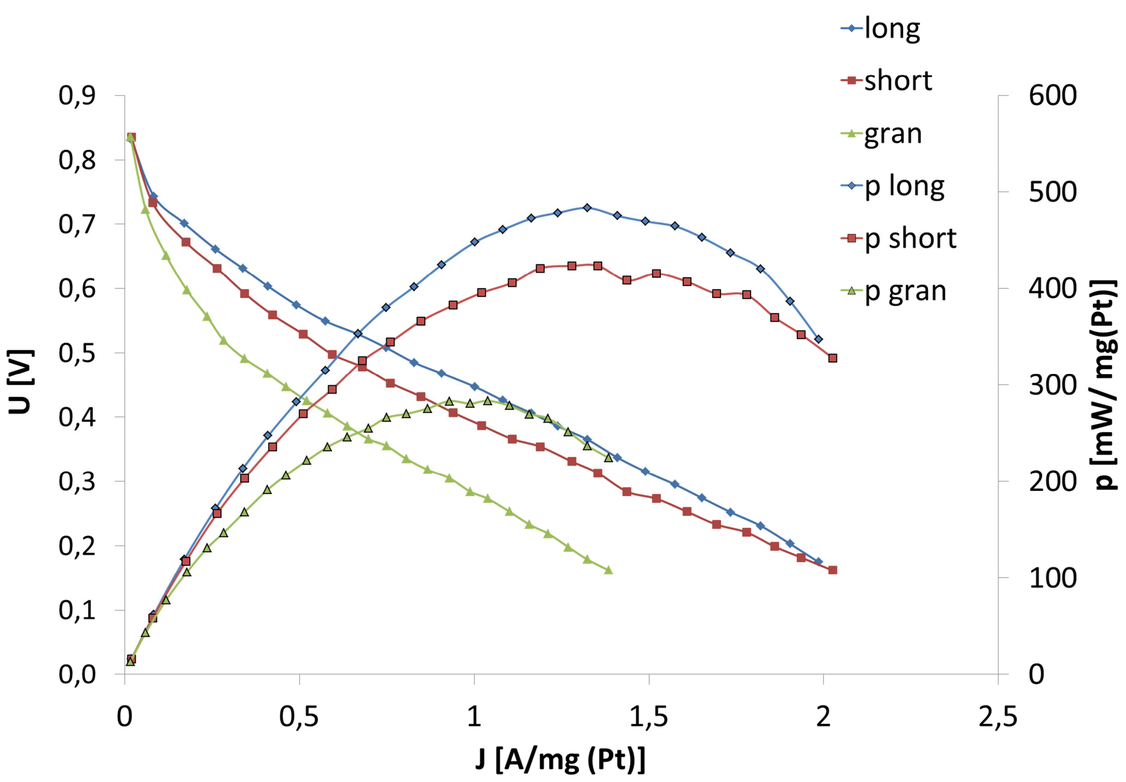


Fig. 4: The Fuel cell performance with the cathode prepared by the different carbonized PANI materials. **Long-** and **short-** fibers, and **granular** support material

The electrodes show significant differences in their electrical characteristics.
The best performance is optained using long fibers, the lowest by using granular support matierial.

References

[1] S. Litster and G. McLean, Journal of Power Sources, vol. 130, no. 1–2, pp. 61–76, May 2004
[2] M. Trchová, et al. Polymer Degradation and Stability, vol. 94, no. 6, pp. 929–938, Jun. 2009
[3] A. Wolz, et al., J. Power Sources 2010, DOI: 10.1016/j.jpowsour.2010.06.087

Structural Characterization

Electronmicroscopy of PANI

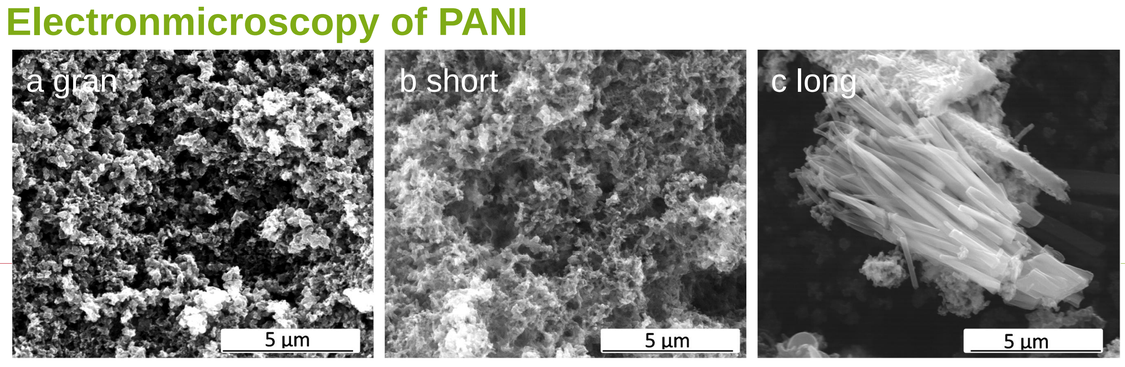


Fig. 1: huge changes in the morphology are due to only slight changes in the reaction conditions. a: in 0.1 M H2SO4, b: in 1 M H2SO4, c: in 0.4 M HAc

Infrared Spectroscopy of PANI

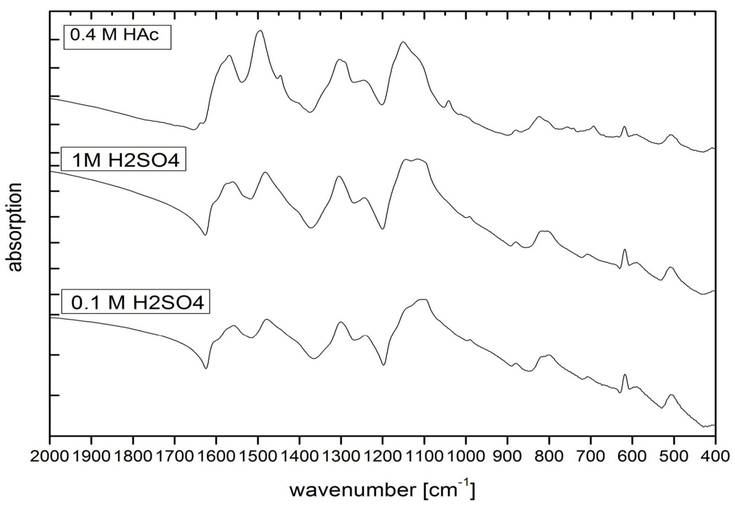


Fig. 2: The IR measurements of the three different synthesized PANI are very similar, which implies an identical chemical composition.
The characteristic absorption bands are present:
quinonoid ring stretching at 1585 cm^{-1}, benzenoid ring stretching at 1497 cm^{-1}, C-N stretching at 1300 cm^{-1}, C-N^+ stretching at 1244 cm^{-1}, benzoid-NH^+ stretching at 1150 cm^{-1} and aromatic C-H out of plain vibration at 823 cm^{-1}

Elemental Analysis and Average Pt Particle Size

Tab. 1: elemental analysis and XRD measurements show no differences between each synthesis rout

	before carbonization			after carbonization		
	long	Short*	granular	long	short	granular
C	57,75 %	31,00 %*	54,95 %	78,80 %	78,20 %	81,60 %
N	10,88 %	5,70 %*	10,10 %	12,00 %	11,20 %	11,45 %
S	5,07 %	15,30 %*	5,75 %	0,08 %	0,50 %	0,05 %
H	4,75 %	4,70 %*	4,85 %	2,00 %	1,45 %	1,97 %
d-Pt	amorphous	< 2 nm	< 2 nm	< 3 nm	< 3nm	< 3 nm

* This data is believed to be influenced by a insufficient washing process after filtration. It is not comparable to any literature data. New measurement are under investigation.

Electronmicroscopy of carbonized PANI

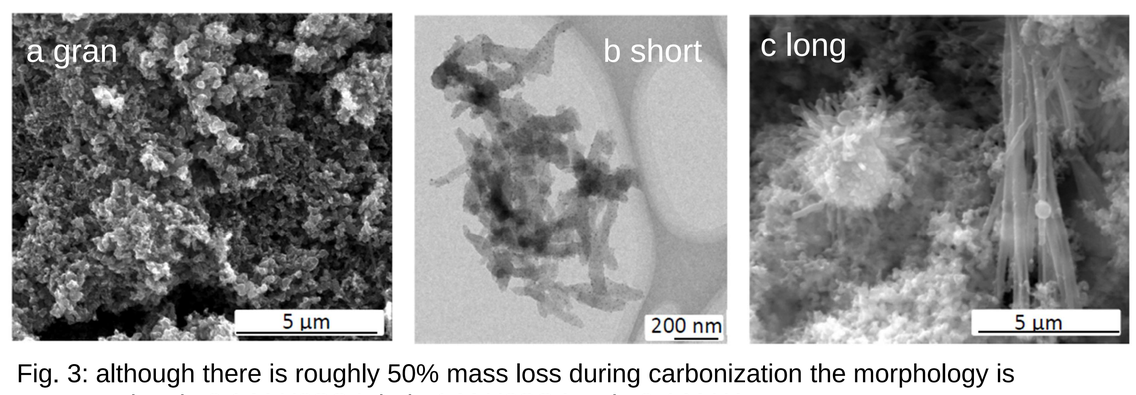


Fig. 3: although there is roughly 50% mass loss during carbonization the morphology is conserved; a: in 0.1 M H2SO4, b: in 1 M H2SO4, c: in 0.4 M HAc

Conclusion

Electrode supports with different morphologies have been prepared by carbonization of PANI synthesized either in 1M H2SO4, 0,1M H2SO4 or 0,4 M HAc. These carbon materials have successfully been used as support for fuel cell cathodes. The performance of the fuel cell differs considerable due to the electrode structure.
Further studies on the long term stability of these structures are under investigation.

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