New Concept of Electronically and Protonic Conductive Polymer Structures for the Proton Exchange Membrane Water Electrolysis Produced by Additive Manufacturing

Annabelle Maletzko, Linda Brösgen, Christian Tchoffo Kaffo, Eduardo Daniel Gomez Villa, Julia Melke, Patrick Weiss, Christof Hübner, and Carl-Christoph Höhne*

[all] Fraunhofer Institute for Chemical Technology ICT, Joseph-von-Fraunhofer Str. 7, 76327 Pfinztal, Germany

* **carl-christoph.hoehne@ict.fraunhofer.de**

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Introduction

To achieve a widespread deployment of polymer electrolyte membrane (PEM) water electrolysis, the investment cost has to be lowered considerably. This poster describes a new design for a polymer-based multifunctional porous transport layer (PTL) to be manufactured by additive manufacturing (AM) and first results.

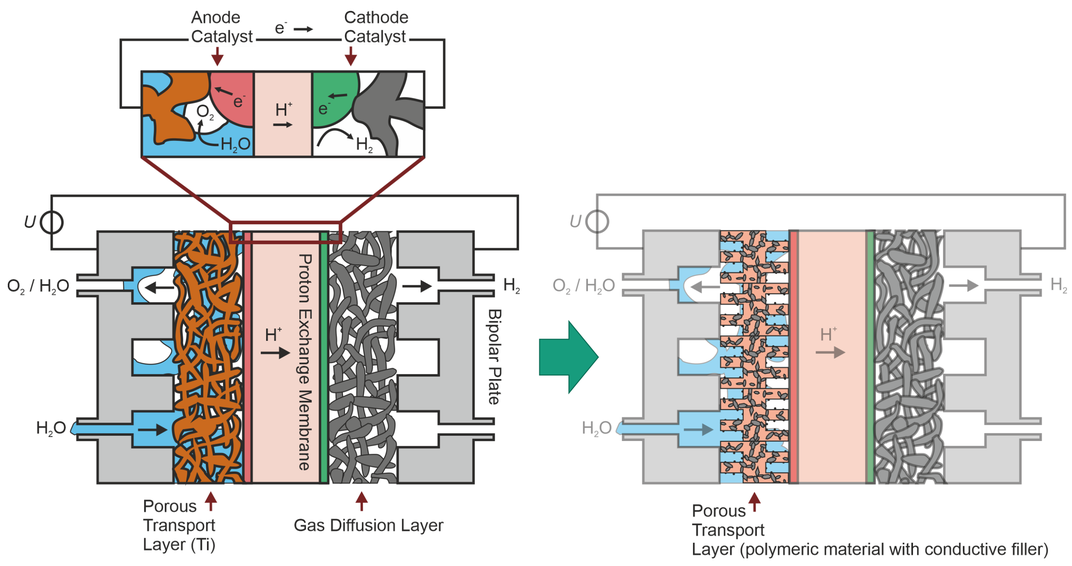

Fig. 1 Left: State of the art PEM water electrolysis; Right: New multifunctional PTL concept.

Experimental

Polymer compounds were prepared by melt-extrusion. Filaments for AM were produced by injection molding and by filament extrusion. They were used for AM or granulated and pressed into foils.

Results

PTL Design:

- Main structure: grid-shaped scaffold structures from PLA/CNT
- Structure interspaces: filled with water-soluble PVA/TiO_2 (TiO_2 as catalyst model material)
- High degree of grid stability due to layer offset between layers of the same orientation
- After PVA/TiO_2 removal: TiO_2 particles remained on structure surface
- Porous structures size range:
  - 150 µm structure height (1st layer: 100 µm, 2nd & 3rd layer: 25 µm)
  - 300 µm line width

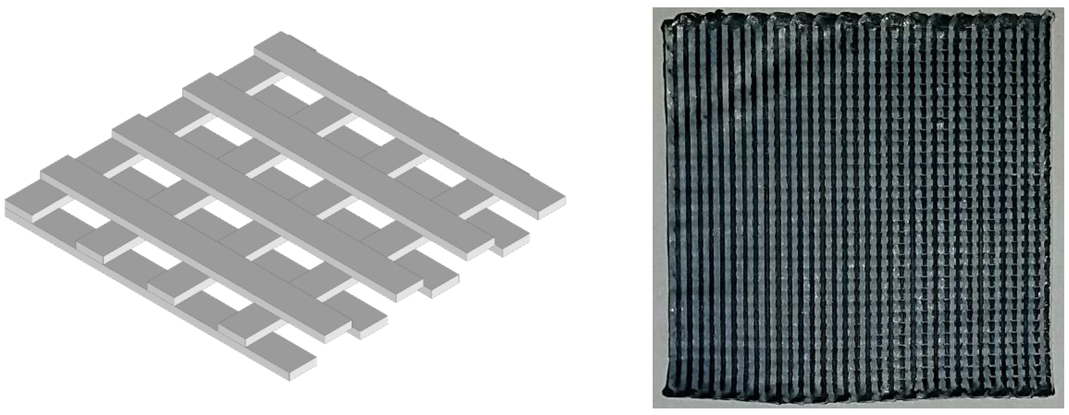

Fig. 2 Left: PLT model; Right: Structure printed by two-component FDM.

Electrical Conductivity

PLA/CNT compounds - through-plane measurements:

- Conductivity increases with higher CNT amount
- Conductivity of pressed foils higher than printed structures
- Printed grids show conductivity → electrons can be transported between printed strands
- Used compounder type shows significant impact on conductivity
- Reasonable electrical conductivity of foils: 5 wt.-% CNT

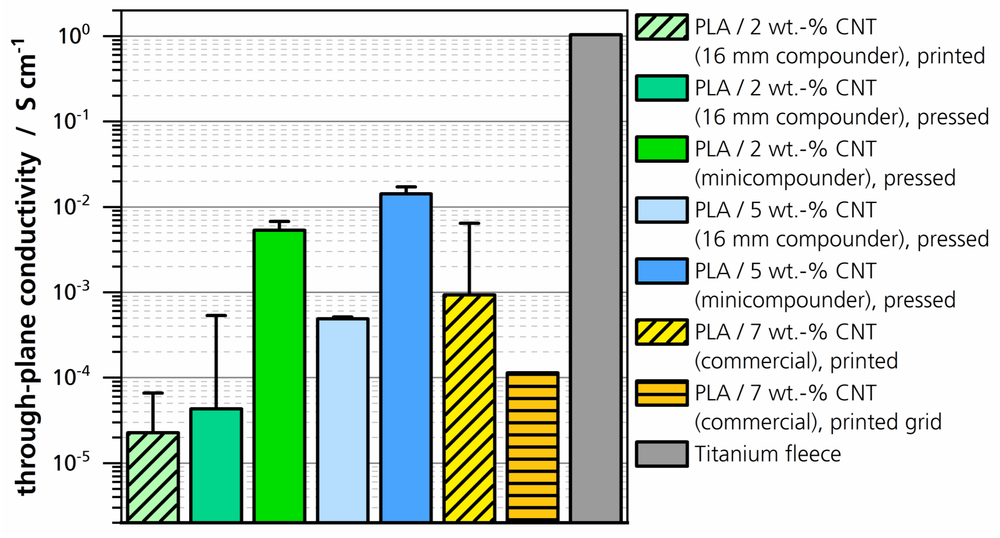

Fig. 3 Through-plane conductivity of different PLA/CNT compounds.

Nafion™ precursor/CNT compounds – cyclo voltammetry:

- Nafion™ precursor: insulating behavior
- Nafion™ precursor/CNT: electrical conductive
- Increasing CNT amount increases conductivity
- Percolation threshold: 3-5 wt.-% CNT

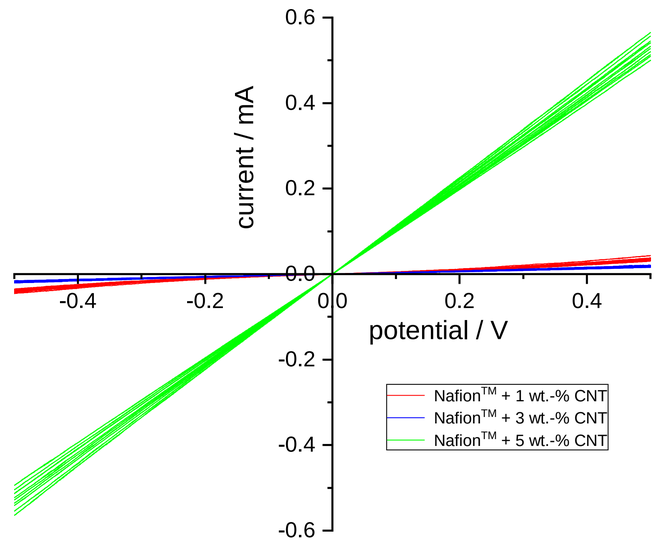

Fig. 4 Cyclo voltammetry of Nafion™ precursor/CNT compounds.

Conclusions

Grid-shaped scaffold structures with a particle loaded surface can be realized by AM of electrical conductive polymer compounds demonstrated by PLA/CNT-PVA/TiO_2. The AM of Nafion™/CNT compound is currently under investigation.

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Further information:
www.ict.fraunhofer.de/de/projekte/3D-PakT

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