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

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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.

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

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 compounding type shows significant impact on conductivity
- Reasonable electrical conductivity of foils: 5 wt.-% CNT

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

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