SCALING-UP OF THE EPOXY RESIN/GRAPHITES COMPOSITES BIPOLAR PLATES FOR PEMFCs

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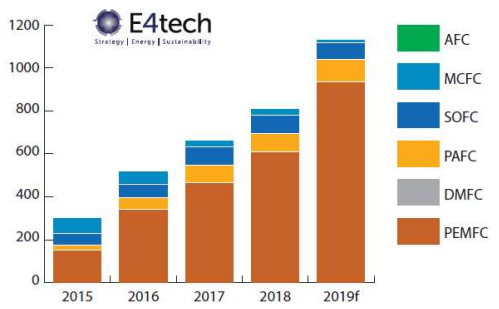
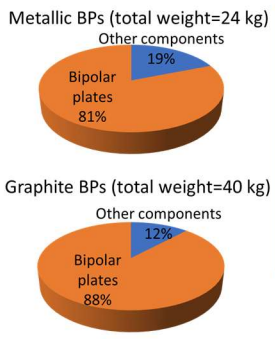
Introduction

[1]Megawatts by fuel cell type 2015-2019



Motivation

[2,3]Mass distribution of 33 kW stack



[4]The bipolar plate (BP) is one of the key components of FCs

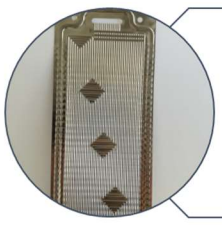
- It connects each cell electrically.
- It conducts electricity.
- It supplies reactant gases to both anode and cathode.
- It removes reaction products and the heat from the cell.

Goals

Scale-up from laboratory samples to small fuel cell bipolar plate, and finally to stack bipolar plate.

Obtain polymer composites bipolar plates by compression molding with the same properties and performance as the commercial graphite bipolar plates.

Why polymer composites BPs?



Metallic

- High electrical and thermal conductivity
- Low chemical resistance

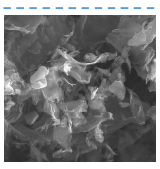
Graphite

- High conductivity and chemical stability
- Low mechanical properties

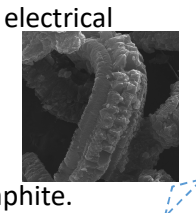
Polymer composite

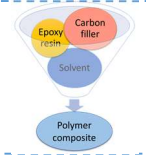
- High corrosion resistance and better mechanical properties
- Final properties depend on matrix and fillers

Tasks

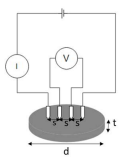


Choosing carbon based electrical conductive fillers. Preparing electrical conductive filler, thermally expanded graphite.

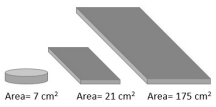




Developing procedure of compression molding of epoxy/carbon filler composites.

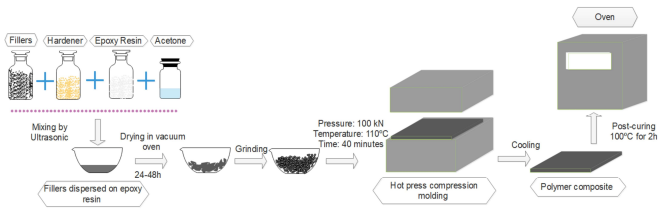


Measuring of the electrical conductivity, permeability, etc.



Scaling-up to BPs with different size and design.

Experimental process



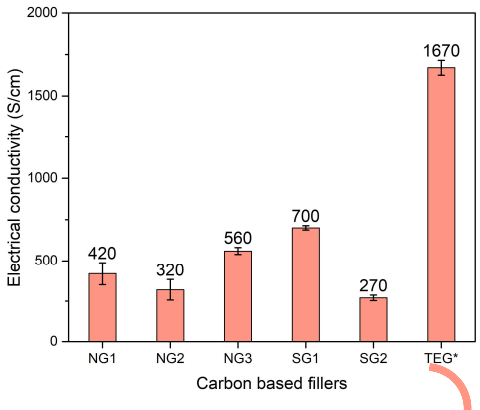
- Polymer composites (laboratory scale)

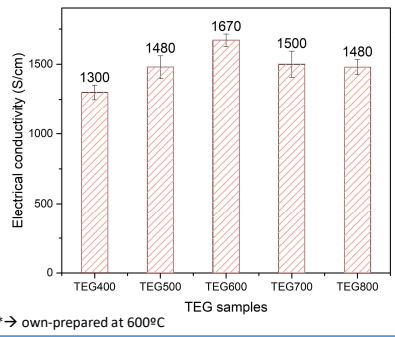
- Fuel cell station's BPs

- Stack's BPs

Carbon based fillers

Electrical conductivity of fillers

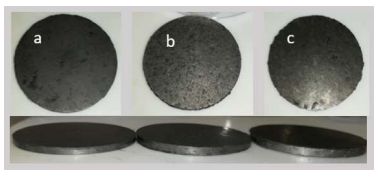




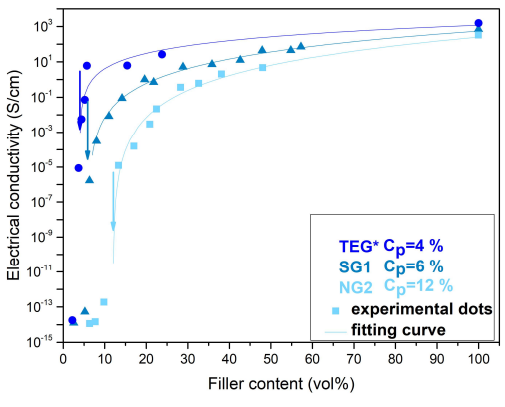
TEG* → own-prepared at 600ºC

Polymer composites samples and BPs

Polymer composites (laboratory scale)



Percolation curve



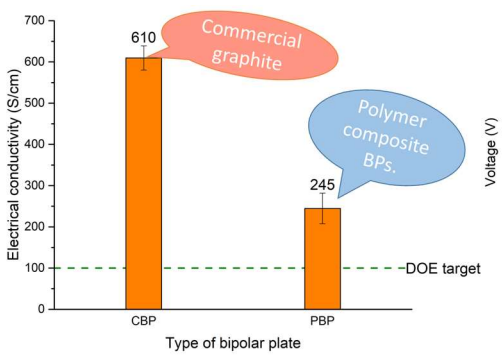
H_2 permeation coefficient for polymer composites

Differential pressure (ΔP) method (mol·m/s·m²·Pa)	Electrochemical (EC) method (mol·m/s·m²·Pa)
2.7E-14	7.7E-15

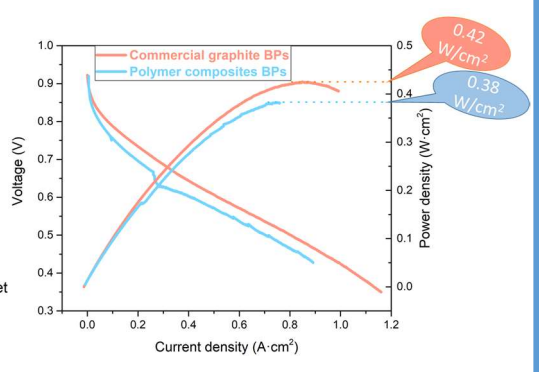
Scale-up of BPs from laboratory scale to small fuel cell

Dimensions: 7.2x3 cm
Thickness: 2.5 mm
Composition: 90% filler + 10% Epoxy resin
Active surface area: 5 cm²

BPs' electrical conductivity



Test in a real fuel cell station



Scale-up of polymer composites BPs from small cell to stack cell

Dimensions: 22x8 cm
Thickness: 4 mm
Composition: 90% filler + 10% Epoxy resin
Active surface area: 100 cm²
Electrical conductivity: 75 S/cm

Conclusions:

- The polymer composites based on the epoxy resin and carbon-based fillers were prepared by compression moulding.
- The percolation behaviour of the composites with different content of fillers was investigated.
- The level of the electrical conductivity and permeability coefficient of composites were measured.
- Prepared BPs were tested in the fuel cell station and it demonstrated the same performance as the commercial graphite BPs.
- The scaling-up of the polymer composites BPs from small cell to stack cell was achieved successfully.

References:

1. The Fuel Cell Industry Review 2019 (E4tech)
2. Napporn, T.W. Polymer electrolyte fuel cell (2018).
3. Li, X. Review of bipolar plates in PEM fuel cells: flow-field designs (2005).
4. Adapted from Hoogers, G. Fuel cell technology handbook (2003).