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Ph.D. thesis (2023-2026)
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Development of conductive bio-based composites for printed PEMFC

Développement de composites biosourcés conducteurs pour les PEMFC imprimées

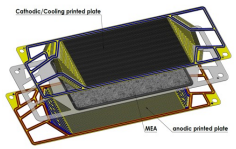
FunPrint

Context / Objectives

Printed PEMFC* developed by CEA

**Protonic exchange membrane fuel cell*

Advantages of printing: lightweight, compact, roll to roll industrialization, flexible in implementation.



Printed bipolar plates in PEMFC

Printing of fluidic channels to distribute gases and cooling, conduct electrons, water management and mechanical strength of the cell

Carbon composites printed on carbon coated foils
But based on harmful fluoropolymer incompatible with potential European legislation

Objective : Replacing the fluoropolymer in the composite with a bio-based polymer

Composite specifications

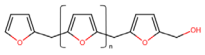
- Composition: bio-based binder + carbon fillers
- Resistant in PEMFC environment: resistant to heat (80 °C), water/moisture and acids (pH = 3)
- Electrical conductivity > 100 S/cm and Areal specific resistance < 0.01 Ω.cm² and low deformation under 1 MPa

Funded by: cea liten

Methods

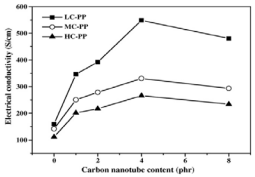
Biobased polymeric bider compatible with PEMFC environment, with printing processes, and good resistance to heat, carbonization potential:

Polyfurfurylic alcohol (PFA)



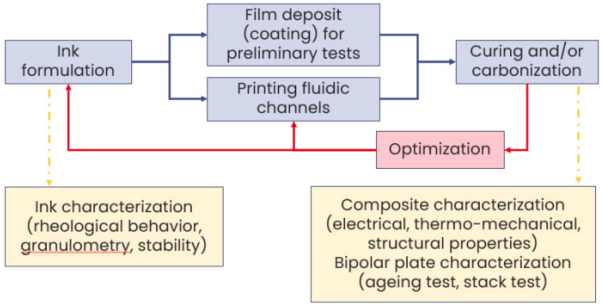
Carbon fillers to provide electrical conductivity to composite. Multi-charge composite to increase the number of percolation paths and create a maximum for conductivity:

Graphite (G) + Carbon Nanotubes (CNT)



Conductivity for bipolar plate: optimum for 20%wt PP binder, 80%wt G and 4 phr CNT (Liao and al. 2008)

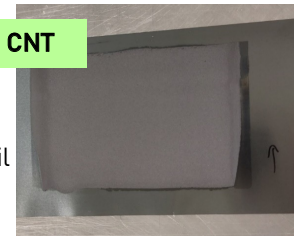
Process and characterization



Results

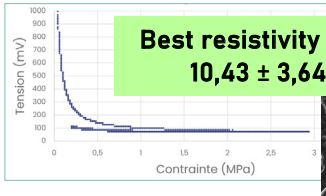
1) Ink formulation

PFA + G + CNT

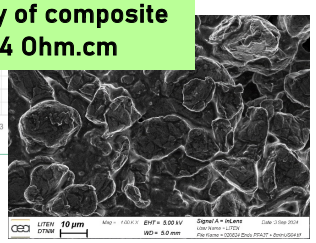


2) Film coating on carbon foil + Cured 90°C – 130°C

3) Composite characterization

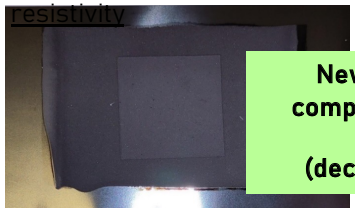


Best resistivity of composite 10,43 ± 3,64 Ohm.cm



SEM structural observation

4) Carbonization treatment to reduce the resistivity



New resistivity of composite 1,63 ± 0,30 Ohm.cm (decreases by 84%)