Superhydrophobic electrosprayed deposits: breakthrough method for water management in PEMFCs

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Motivation

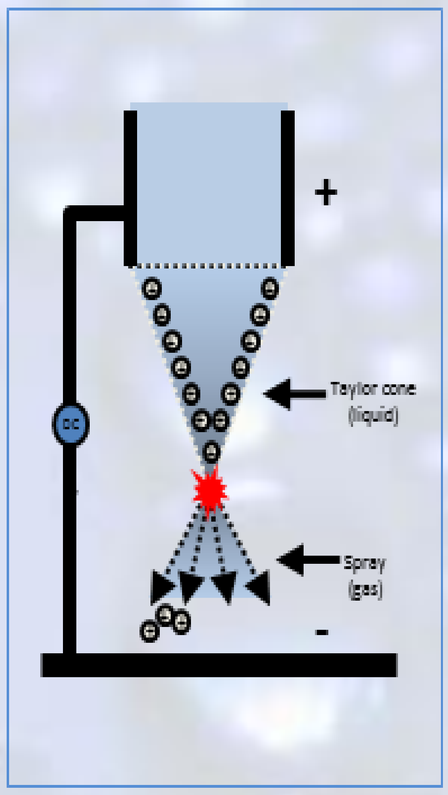
PEM Fuel Cell technology is called to lead the future to a cleaner and more secure energy system. Although PEMFC are fairly well developed and reliable devices, there are still some issues to be solved to further increase their performance, particularly in non-standard configurations, such as air-breathing devices. One of those challenges is the improvement of water distribution. Our approach consists of using superhydrophobic media in different parts of the cells to facilitate the removal of excess water from the electrodes and improve water distribution within.

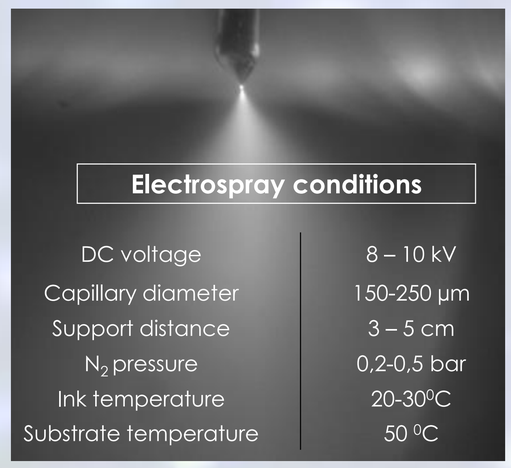
Electrospray Deposition method (ESD)

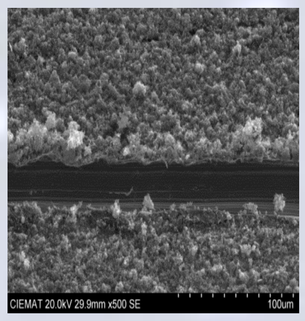
It consists of the application of a high **dc voltage** between a metallic needle and a substrate. The catalyst suspension will be **electrochemically ionized** and ejected under electrostatic interactions.

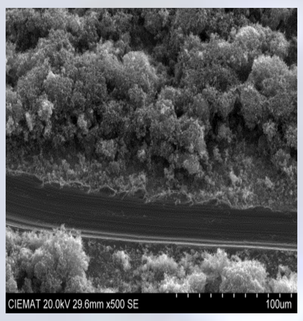
ADVANTAGES:

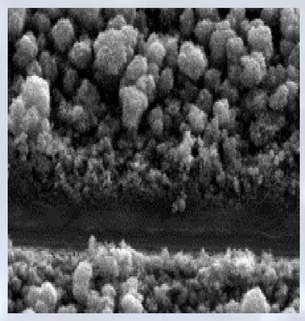
- **Better catalyst utilization**:
  Charged catalyst particles are electrically attracted towards the negative charged substrate
- **Advanced microstructure**:
  Increased macroporosity and hydrophobicity compared to standard methods
- **Allow the use of complex substrates:**
  Electrostatic interactions of the particles with the substrate permits using non-planar substrates





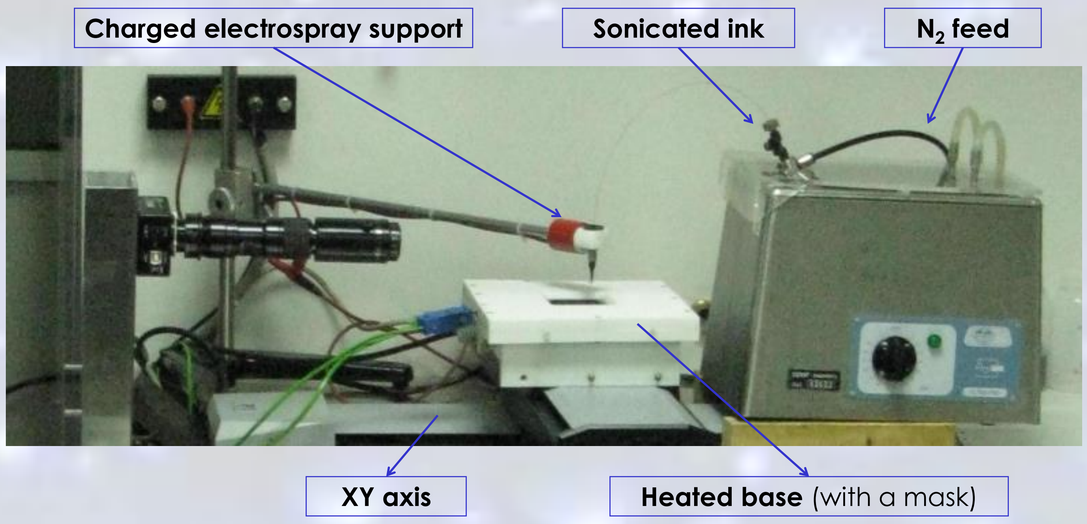






Experimental set-up

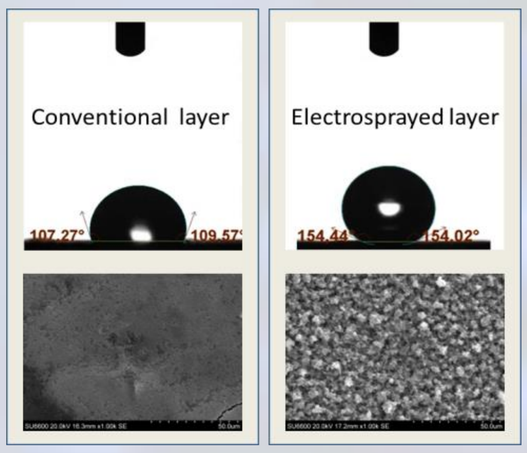
- **Allows to either use electrospray or airbrush deposition with the same equipment, just by changing the capillary support.**
- **Controlled ink flux**:
  By using N_2 to generate pressure on the ink flask, the flux can be precisely controlled.
- **Excellent dispersion of the ink**:
  The bulk of the ink is continuously sonicated inside the flask.
- **Homogeneous deposits**
  By the use of a motorized XY axis.

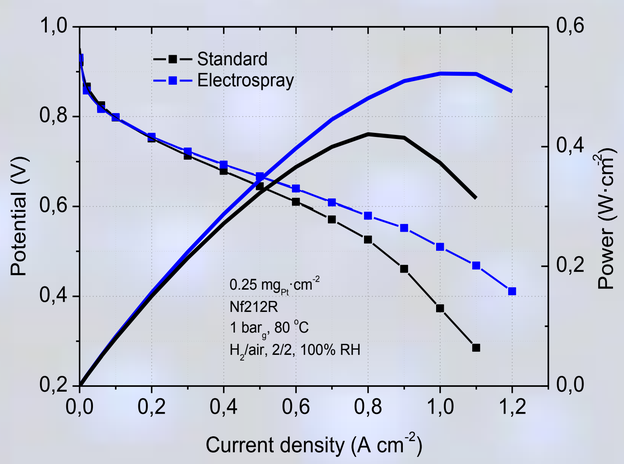


Application of electrosprayed deposits

The electrospray allows the growth of catalysts with **high macroporosity and dendritic shapes**. Such morphology **confers superhydrophobic character** to the layer.

When used in **catalyst layers**, we reported **performance increase** usually **above 20%** with respect to cells using commercial catalysts.





Carbon electrospray is an ideal method to cover the metallic parts within a PEM fuel cell.

- Electrically conductive deposits
- Surface hydrophobicity
- Corrosion protection

Current collector grids

Electrosprayed grid with HSAG graphite in a current collector grids used in air-breathing PEM fuel cells.

Bipolar plates

Electrosprayed CB in gas channel of a bipolar plated.

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