Electrospun materials as electrocatalyst supports for PEM fuel cells

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It is known that one of the major issues concerning durability of PEMFC (Proton Exchange Membrane Fuel Cells) is the electrode degradation over time. Conventional electrocatalyst supports, based on carbon black, in fuel cell conditions suffer from corrosion leading to the aggregation, migration and detachment of the electrocatalyst nanoparticles with loss of performance[1]. One strategy to overcome this issue is the replacement of carbon with more (electro)chemically stable supports. Recently, materials such as conducting oxides, nitrides and carbides have been shown promising applications as alternative supports[2].

Novel nanostructured 1D materials such as nanotubes and nanofibres have also attracted significant research attention as PEMFC catalyst supports due to the influence of their nanostructure and morphology on performance and durability. In this regard, the electrospinning technique is an attractive technique for the synthesis of nanofibres with controlled and uniform diameters and structures[3]. Its versatility allows the production of organic as well as hybrid and inorganic nanofibres. Furthermore, the possibility of creating different geometries (core-sheath, hollow fibres,..), assemblies and architectures (aligned or nonwoven fibres, cross-bars,...) greatly increases the range and variety of materials that can be achieved.

We are developing novel nanofibre based PEMFC electrodes by electrospinning, using conventional (carbon), but also alternative materials (TiO_2, SnO_2) (see Figure 1).

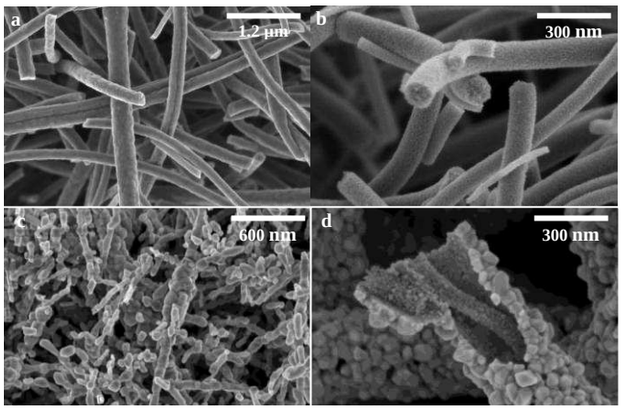

Figure 1. SEM micrographs of carbon (a), Nb doped TiO_2 anatase (b), TiO_2 rutile (c) and SnO_2 (d) electrospun materials.

The challenges to be addressed are related to the development of nanofibres having sufficient surface area to support and well disperse the electrocatalyst nanoparticles, while ensuring adequate electronic conductivity. With that aim, thermal treatments in reducing atmosphere and/or doping with metallic ions are the strategies we employed in order to increase the conductivity of these semiconducting materials.

Finally, electrodes were prepared by depositing platinum nanoparticles on the surface of the fibrous supports, obtained by a solvent assisted or a one-step method[4].

In this communication, we will focus on the comparison in term of morphology and physical-chemical properties of supports based on electrospun carbon and oxide fibres (Nb doped TiO_2 and SnO_2). The electrocatalytical activity of these systems will also be addressed, in particular towards the oxygen reduction reaction, of crucial importance in PEMFC. Furthermore, accelerated corrosion tests will be presented in order to compare the resistance to corrosion of electrospun materials to the one exhibited by conventional carbon based supports and assess their greater stability.

References

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