

Doped mesoporous materials as PEM fuel cell electrocatalyst support.

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Proton exchange membrane fuel cells (PEMFC) are widely recognized as very attractive devices to obtain directly electric energy from chemical reactions with zero/low emissions [1]. However, fuel cell technology depends largely on two key materials: the membrane and the electrocatalyst [2]. New membrane and electrode materials are required to increase power density and/or decrease cost.

Carbon particles are frequently used as catalyst supports. High performance PEMFC electrodes require an efficient three-phase reaction zone at nanometric scale, where the electrochemical reactions occur on the metal nanoparticles surface involving electron and proton transport. In addition, it also requires the provision of an efficient transport passage for reactants and products.

In this work a novel catalyst support is proposed. Mesoporous materials as MCM-41 (pore range 2-5 nm) and SBA-15 (pore range 3-10 nm) are interesting materials for fuel cell application because their high surface area, high stability in basic and acid media, ionic conductivity and low cost [3]. These supports were doped with aluminum and tin to improve their electronic conductivity. Aluminum and tin were incorporated from the MCM-41 and SBA-15 synthesis. Alternatively microporous supports were also synthesized for comparison.

The influence of the pore size and the dopant agent were analyzed. Structural features and textural properties were characterized by X-Ray powder diffraction (XRD) and nitrogen adsorption techniques. Electrical properties were also evaluated. Kelvin method technique and electrochemical impedance spectroscopy (EIS) were used to know the electrical and ionic conductivity respectively.

Figure 1 shows the XRD patterns obtained for each material. In this figure is possible to observe the MCM-41 and SBA-15 planes (100), (110) and (200) at low angles (black numbers for SBA15 materials and blue numbers for the MCM41 materials). These results indicate that the mesoporous structure supports were not affected with the incorporation of dopant agent.

High surface areas were obtained in all supports synthesized as shows in Table 1. The pore size results are in agreement with XRD results, which indicate the presence of doped mesoporous supports.

EIS results can be seen in Figure 2. The impedance is very high in a dry ambient operation and can be interpreted with a simple RC circuit (Fig. 2A). However, the supports evaluated in a wet ambient reduce their impedance (Fig. 2B). A R(R1Q1)(R2Q2) model circuit was employed for interpretation. The electrical properties as ionic transport, polarization phenomena, grain boundaries capacitances and interface electrode-

electrolyte will be discussed.

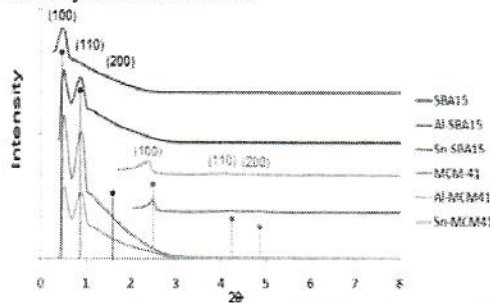


Figure 1. Powder X-Ray Diffraction patterns of undoped and doped mesoporous supports.

Table 1. Pore size and surface area obtained in synthesized electrocatalyst supports.

Sample	S _{BET} (m ² /g)	Pore size (nm)
FAU X*	180	1.3
Linde-A**	431	0.5
MCM41	1219	2.5
Al-MCM41	1272	2.5
Sn-MCM41	1056	2.2
SBA15	863	7.7
Al-SBA15	1128	9.6
Sn-SBA15	754	12.3

* Microporous zeolite type faujasite.

** Microporous zeolite type Linde A.

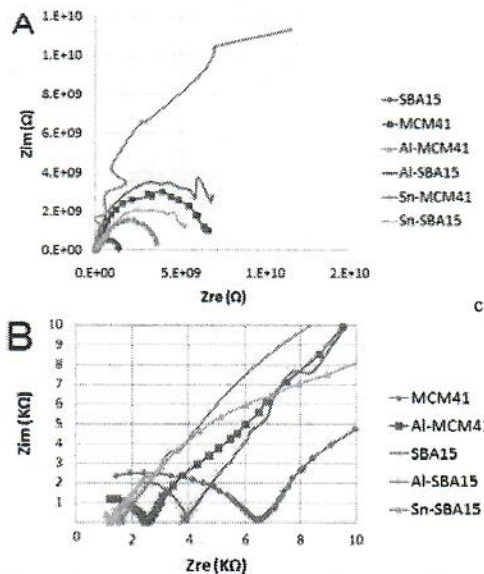


Figure 2. Nyquist diagram for mesoporous supports. A) Dry ambient operation and B) Wet ambient operation.

References

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