NEW CHEMICAL ROUTES FOR PREPARATION OF ULTRAFINE NiO-YSZ POWDERS FOR SOFC ANODE APPLICATIONS

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Physical and chemical properties of ceramic materials are highly dependent on the morphology and chemical composition of starting powders. Moreover, good conductivity, chemical and thermal stability, and especially electrochemical activity are key factors to improve the performances of the SOFCs (1).
A typical SOFC system employs yttria-stabilized-zirconia (YSZ) as solid electrolyte and cermet nickel-yttria-stabilized-zirconia (Ni-YSZ) as anode material. In a conventional cermet microstructure prepared from NiO and YSZ mixed powders, the grains of the oxides are randomly distributed. The sintering of NiO grains cannot be avoided (2). This fact reduces the length of the triple phase boundary.
The aim of this work is to synthesize ultra fine NiO-YSZ composite powders with an high dispersion level of the NiO (about 40% molar), controlling the morphology of the particles by using two new chemical routes. The two methods allowed to obtain nanostructured powders as starting materials to get high performance anode for SOFC applications.
The processes used to obtain green bodies were: a sol-gel and a liquid mixture methods. Recently, a sol-gel process using an aqueous preparation of metal-YZ has been developed to obtain nanostructured material with mesoporosity (3). The same technique has been used in this work to obtain NiO-YSZ with nanoscaled grain size. A liquid mixture process is a new way to impregnate nanometric YSZ powder by using nickel acetate. The acetate is fired and eliminated forming nanosized NiO particles spread on the surface of YSZ. The firing did not change the morphological and chemical bulk properties of the ionic conductor material. The green bodies were calcined at selected temperatures between 450 and 1000°C. A sintering at 1350°C was also performed to study the growth of NiO grains for anode fabrication (4).
Material characteristics such as porosity, NiO particle distribution, grain size and particle to particle contact were investigated by SEM and FE-SEM for powders investigated. In figs.1 and 2 the FE-SEM micrographs of the NiO-YSZ powders fired at 450°C obtained using the two different chemical routes are reported. X-ray diffraction (XRD) and Energy-dispersive analysis of X-rays (EDAX) were used to study the phase and chemical composition of the materials. In fig. 3 the XRD and EDAX of the NiO-YSZ powder fired at 700°C and obtained using the liquid mixture method is shown. The evolution of precursors was also studied by FT-IR and TG/DTA.
Different morphologies were observed for the NiO-YSZ powders obtained by the two methods, probably due to the differences in the starting materials. Very small grains of each phase, NiO and YSZ, can be achieved using both preparation methods. Both the two chemical routes seems to be promising for ultra-fine NiO-YSZ powders for high performance SOFC anode applications.

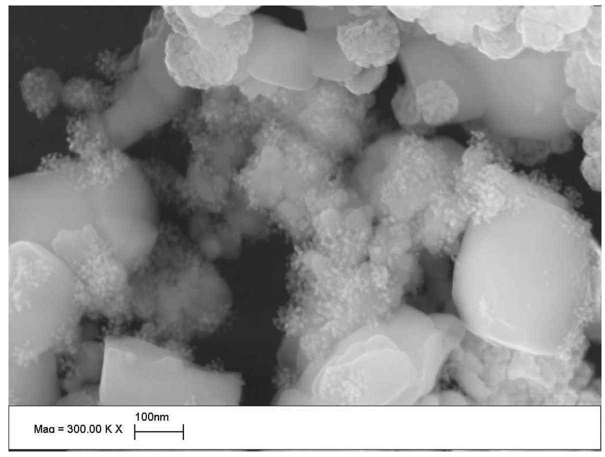

Fig. 1: FE-SEM micrograph of the NiO-YSZ powders fired at 450°C obtained using the liquid mixture method.

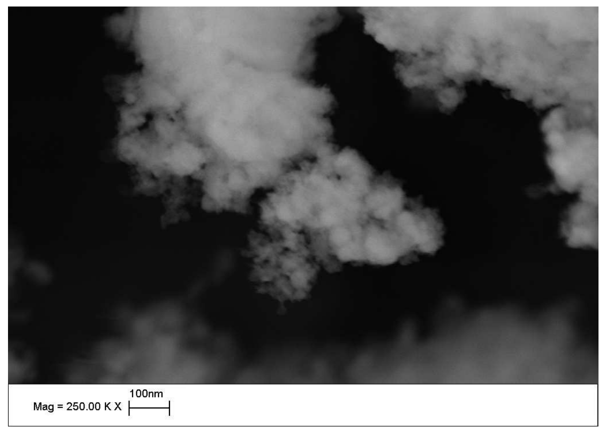

Fig. 2: FE-SEM micrograph of the NiO-YSZ powder fired at 450°C obtained using the sol-gel method.

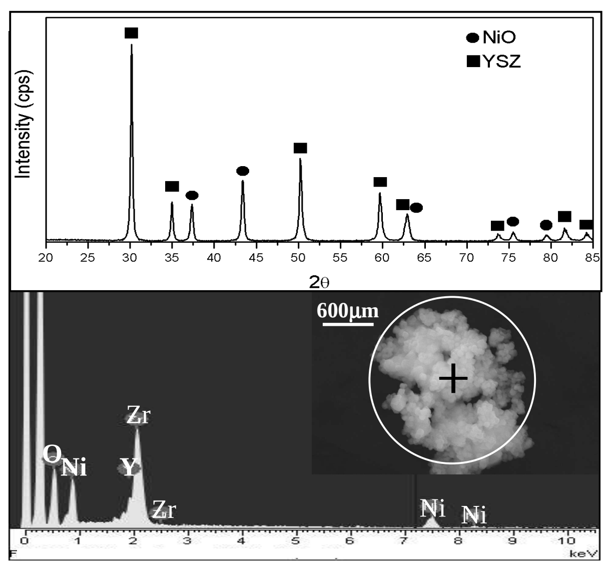

Fig. 3: XRD and EDAX of the NiO-YSZ powder calcined at 700°C and obtained using the liquid mixture method.

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