11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Ni-CGO composite for SOFC anode : Synthesis and Characterization

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Abstract – Composite anode has been synthesized by several methods, like coprecipitation, polymeric precursors, combustion, solid state reaction [1-4]. In this work compounds of gadolinium-doped ceria, $Ce_{0,9}Gd_{0,1}O_{1,95}$ (CGO) and NiO were synthesized by polymeric precursors method. The composite NiO- $Ce_{0,9}Gd_{0,1}O_{1,95}$ was attained by mixture of the powders of the both phases calcinated already. The materials were characterized by X ray diffraction and scanning electronic microscopy. The refinement of the diffraction data indicated that the powders were crystallized in the wanted phases. All the produced powders had nanometric and sub micrometric characteristics. The composite produced showed good characteristics for the use as anode for SOFC.

The direct use of natural gas makes the Solid Oxide Fuel Cell (SOFC) potentially more competitive with the current energy conversions technologies. The Intermediate Temperature SOFC offer several advantages over the High Temperature SOFC, which includes better thermal compatibility among components, fast start with lower energy consumption, manufacture and operation cost reduction [5]. The CeO_2 based materials are alternatives to the Yttria Stabilized Zirconia (YSZ) to application in SOFC, as they have higher ionic conductivity and less ohmic losses comparing to YSZ, and they can operate at lower temperatures (500-800℃). These electrolytes based in ceria require special electrodes with a higher performance and chemical and termomechanical compatibility [6].

The production of this composite had some steps. At first was to produced nanopowders of the two phases, $Ce_{0,9}Gd_{0,1}O_{1,95}$ and NiO, by polymeric precursors synthesis method and calcinated at 800 ℃. This temperature was determined by previous experiments. As a second step both phases' powders were mixtured in a 50-50 weight % proportion, by milling under 60 rpm rotation and 2 hours. Part of the mix powder was used to produce two pellets by pressing under 198 MPa and sintered at 1300 ºC for 30 min.

The mixture powder was characterized by XRD, Figure 1, and the data was refined using Rietveld method and the program BDWS-9807. The crystallographic results are in the Table 1. The sinterized pellet was thermal attacked to show it's microstructure, and was analyzed by SEM, Figure 2. Another pellet suffered a thermal treatment with H_2 atmosphere to reduce the NiO to metallic nickel and was also analyzed by SEM to check if all the nickel had became metallic indeed.

The XRD results confirmed the present only of the two crystalline phases. The SEM results of the first pellet shows that the phase dispersion didn't happen in a nanometric scale, producing some small agglomerate of phases. The analysis also proved that after treatment the NiO was reduced to metallic Ni.

Table 1: Crystallographic data attained by Rietveld refinement of XRD results.

	a=b=c (Å)	d (Å)	D_{XRD} (nm)	ε (%)	Weight %	U	V	W
$Ce_{0,9}Gd_{0,1}O_{1,95}$	5,4180	1,7624	45,84	0,0695	48,56	0,000000	0,090181	0,003594
NiO	4,1760	1,6877	47,82	0,0782	51,44	0,000000	0,044023	0,022630

* R_p = 11,86 %; R_{exp} = 12,47 %, R_{wp} = 16,25 % and S = 1,30.

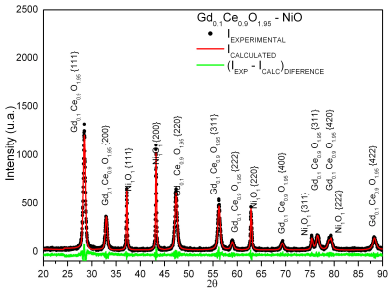

Figure 1: NiO-CGO XRD diffractogram.

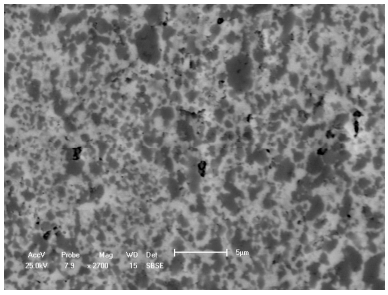

Figure 2: SEM microscopy image of the sintered NiO-CGO pellet.

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