Oxide-oxide composites based on nanopowders functional application

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Abstract

Modern technical progress requires the creation of nanocomposites based on oxide matrix with oxide filler that can be used in various fields of engineering.
In present report we obtained and use nanopowders based on ZrO_2 -3 mol% Y_2O_3, $La_{0.7}Sr_{0.3}MnO_3$ and NiO nanoparticles for creation of magnetic composite for optoelectronic and radioelectronic and for SOFC electrons material.
Nanopowders of $(Zr,Y)O_2$, LSMO were synthesized by co-precipitate method with calcination change of reagent precipitator in ensure synthesis of LSMO allows to exclude bimodal distribution of particle size to monomodal one. Composites obtained by mixing of different of different nanopowders with subsequent sintering. Organic pore formed polymethylmethacrylate (PMMA) was used for creation of predetermined porosity of composites.

Magnetic composites
It has been shown [1] that tape casting technology allows to produce magnetic nanocomposite films of micrometer thickness. The investigation of the morphology of the green film dried at 30ºC shows that the film has a homogeneous structure made from globules of up to 500 nm in size (Figure 1).
Analysis of magnetization curve show that transition from the state with main value of magnetization to saturation condition occurs with sufficiently low expenditure of energy of environmental.

Material of SOFC anode
Modern construction of SOFC consists of two, air and fuel, porous ceramic electrodes and oxygen ion conducting ceramic electrolyte sandwiches between them. These electrode materials must have suitable chemical compositions, sufficient porosity (about 40%) and strength, high number of reaction zones and good catalytic activity. To obtain good electrochemical properties, it is desirable that SOFC components were prepared from nanoparticles [2-3].
TEM image of the mixture of ZrO2 and NiO powder calcined at 800ºC is shown in Figure 2. According to XRD and TEM data, both oxides have cubic lattices. Their size depends on calcination temperature as shown in Table 1.

Table1. Particle size (nm) of ZrO_2, NiO and LSM oxides at different calcination temperature (according to XRD)

T,ºC	700	800	900	1000	1100	1200
ZrO_2	16	21	29	39.8	61	95
NiO	39	52	65.8	70.4	112	150
LSM	20	35	54	60	85	100

NiO-ZrO_2 anode composites were reduced in flow of hydrogen 200 cm3/min at 400-800ºC during 2 hours. Composites sintered from powders calcined at 700 and 1000ºC had 6 and 9% porosity, respectively. The reduction of these samples was not full at named conditions. The full reduction in flow of hydrogen occurred at 800ºC only for powders calcined at 1200ºC ensuring high porosity in NiO-ZrO_2 composite.

Material of SOFC cathode
The growth of ZrO22 and $LaSrMnO_3$ nanoparticles (Figure 3) was observed when calcination temperature was increased (Table 1). At sintering at 1300ºC, porosity of sintered cathode electrode was 0.8% (with no pore former) and 13% (with 10% PMMA). The porosity increases with decreasing of temperature to 1150ºC and was 25% and 45% with no pore former and with it, respectively [3-4].

Acknowledgment

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References

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Figures

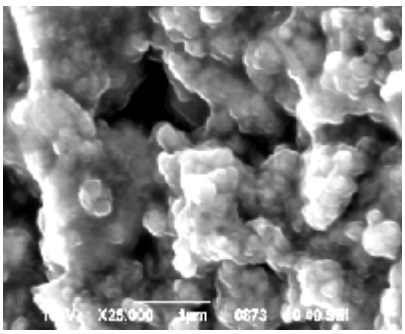


Figure 1. Structure of film based on $La_{0.7}Sr_{0.3}MnO_3$ and ZrO_2-3mol%Y_2O_3 nanopowders

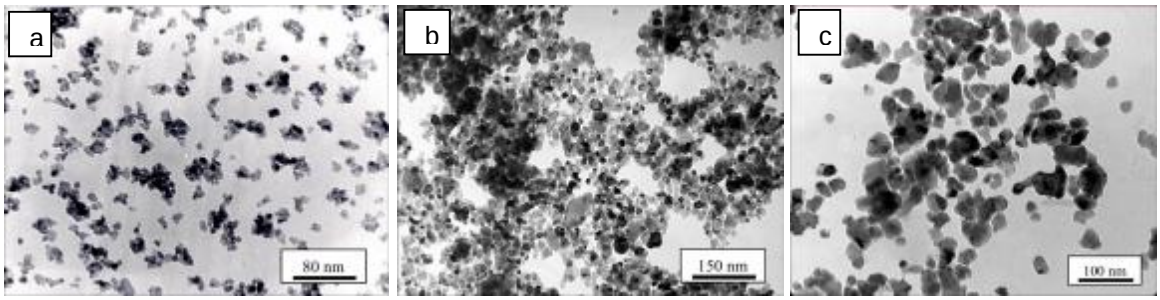
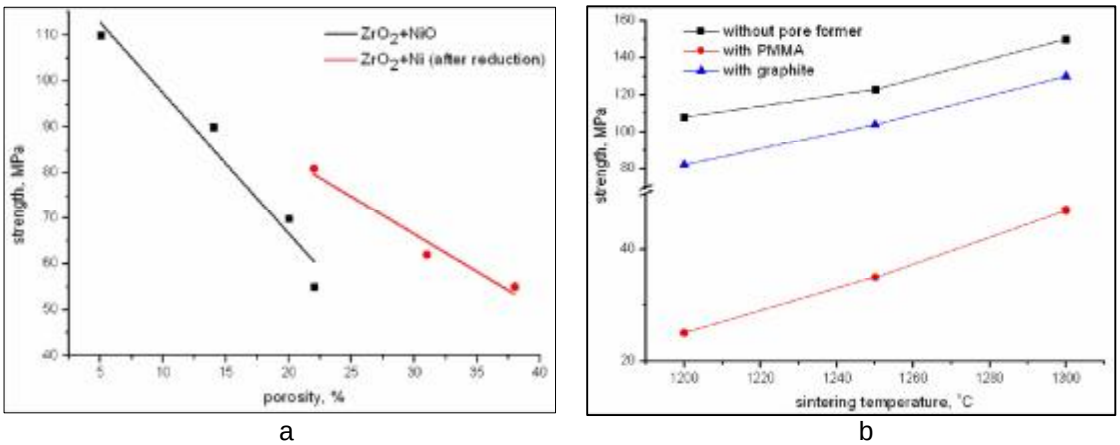


Figure 2. Structure of nanopowders ZrO_2-8mol%Y_2O_3, NiO and LSMO for SOFC anode and cathode



a b

Figure 3. Strength of anode material vs porosity (a) and strength of cathode material vs sintering temperature (b)