Institute of Technical Sciences of the Serbian Academy of Sciences and Arts

MICROSTRUCTURE DEVELOPMENT AND ELECTRICAL PROPERTIES OF NiO DOPED α-Fe_2O_3

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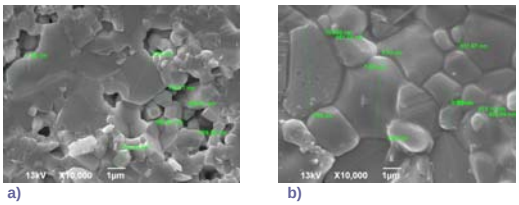
Hematite (α-Fe_2O_3) is an attractive, stable, resistant to corrosion, low cost, n-type semiconductor with a band gap of approximately 2.2 eV recently investigated as an anode material for photoelectrochemical hydrogen production. Its short diffusion lengths of charge carriers and slow surface reaction kinetics are a deficiency to its water splitting efficiency. Doping of pure α-Fe_2O_3 can improve its photoelectrochemical performance.

EXPERIMENTAL

Starting hematite powder with 99.8% purity was doped with 1, 2, 5 and 10 wt.% NiO powder with 99.995% purity, homogenized in a planetary ball mill for 15 min, pressed into pellets and sintered at 900°C, 1000°C, 1100°C and 1200°C for two hours. Sample characterization was performed using SEM, EDS and XRD analyses. Structural refinement was carried out by the Rietveld method using the GSAS package with the EXPGUI graphical user interface. The electrical DC resistivity/conductivity at different temperatures was measured using a High Resistance Meter (HP 4329A).



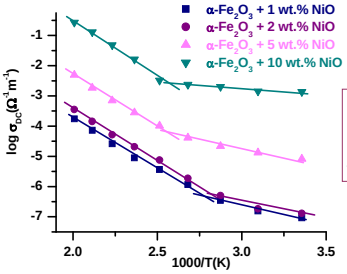
a) b)

SEM images of α-Fe_2O_3 + 10wt.% NiO sintered at: a) 1100°C and b) 1200°C

Grain growth with the increase of sintering temperature is seen from SEM images

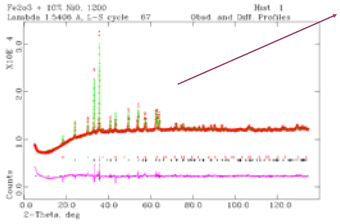
SEM: JEOL JSM-639OLV

Ni doping increases electrical conductivity.

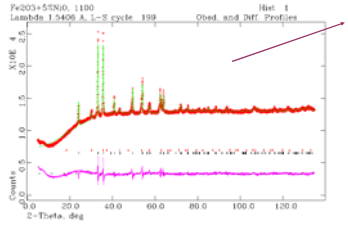


Change of the curve slope suggests the changes in the conduction mechanism with temperature.

RESULTS



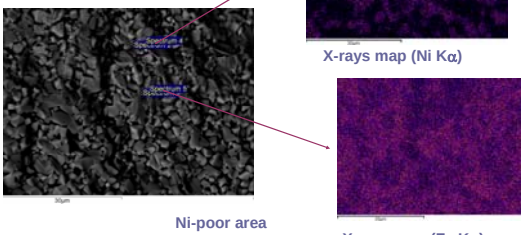
a)

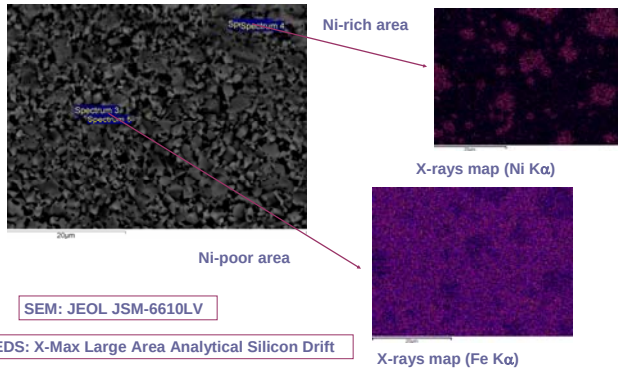


b)

Rietveld plots with observed and calculated XRD patterns for: a) α-Fe_2O_3 + 10wt.% NiO sintered at 1200°C and for b) α-Fe_2O_3 + 5wt.% NiO sintered 1100°C.

XRD: Panalztical X'Pert PRO

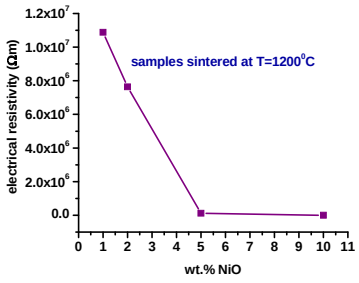




SEM: JEOL JSM-6610LV

EDS: X-Max Large Area Analytical Silicon Drift

XRD patterns showed the presence of two phases: α-Fe_2O_3 (*a*=*b*=5.023(1) Å; *c*=13.708(3) Å; ICSD 88418) and spinel $NiFe_2O_4$ (*a*=8.3379(3) Å; ICSD 28108).



Electrical resistance decreased with increased doping and higher sintering temperatures.