



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

MICROSTRUCTURE DEVELOPMENT AND ELECTRICAL PROPERTIES OF NiO DOPED α -Fe₂O₃

T. Ivetić¹, M.V. Nikolić², P.M. Nikolić¹, V. Pavlović¹, N. Nikolić², O.S. Aleksić²

¹ Institute of Technical Sciences of the Serbian Academy of Sciences and Arts, Knez Mihailova 35/IV, 11000 Belgrade, Serbia

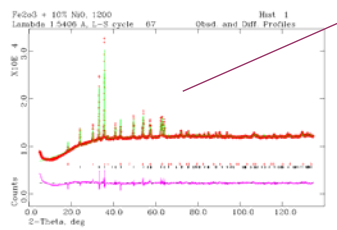
² Institute for Multidisciplinary Research, Kneza Višeslava 1, 11000 Belgrade, Serbia

Hematite (α -Fe₂O₃) 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 -Fe₂O₃ can improve its photoelectrochemical performance.

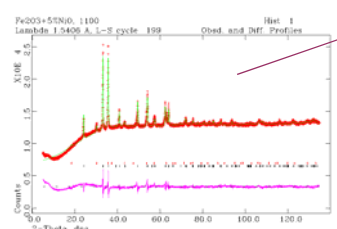
EXPERIMENTAL

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).

RESULTS



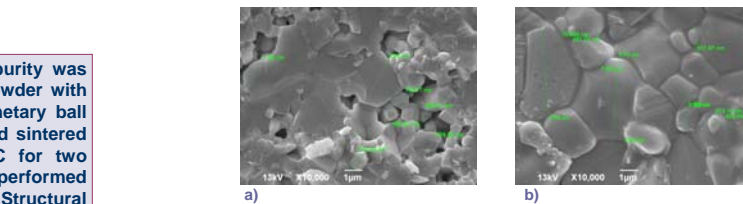
a)



b)

Rietveld plots with observed and calculated XRD patterns for: a) α -Fe₂O₃ + 10wt.% NiO sintered at 1200°C and for b) α -Fe₂O₃ + 5wt.% NiO sintered 1100°C.

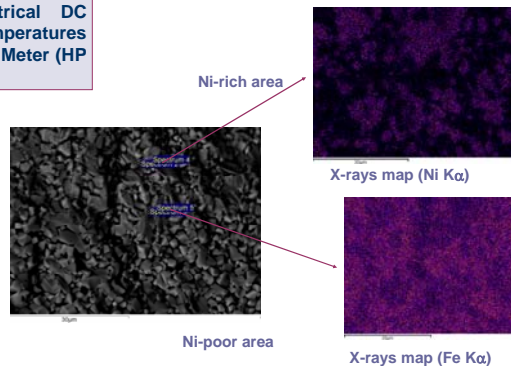
XRD: Panalztical X'Pert PRO



SEM images of α -Fe₂O₃ + 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-6390LV



Ni-rich area

X-rays map (Ni K α)

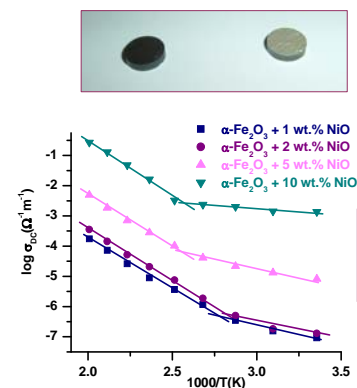
Ni-poor area

X-rays map (Fe K α)

SEM: JEOL JSM-6610LV

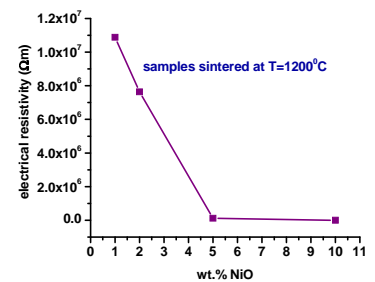
EDS: X-Max Large Area Analytical Silicon Drift

XRD patterns showed the presence of two phases: α -Fe₂O₃ ($a=b=5.023(1)$ Å; $c=13.708(3)$ Å; ICSD 88418) and spinel NiFe₂O₄ ($a=8.3379(3)$ Å; ICSD 28108).



Ni doping increases electrical conductivity.

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



Electrical resistance decreased with increased doping and higher sintering temperatures.