EFFECTS OF STRONTIUM AND SAMARIUM DOPANTS ON THE DIELECTRIC PROPERTIES OF NICKEL OXIDE

NURUL NADIA BINTI MOHD SALIM

UNIVERSITI SAINS MALAYSIA

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by

NURUL NADIA BINTI MOHD SALIM

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LIST OF ABBREVIATIONS

AC	Alternating current
BZT	Barium Zirconia Titanate
EDX	Energy Dispersive X-ray
FESEM	Field Emission Scanning Electron Microscopy
GBBL	Grain Boundaries Barrier Layer
KTNO	Kalium, Titanium doped Nickel Oxide
LTNO	Lithium, Titanium doped Nickel Oxide
LBFO	Lanthanum, Bismuth doped Ferum Oxide
LANO	Lithium, Aluminium doped Nickel Oxide
$Ni_{(1-x)}Sr_xO$	Sr-doped NiO with *x* mole fraction of Sr
$Ni_{(1-x)}Sm_xO$	Sm-doped NiO with *x* mole fraction of Sm
$Ni_{(1-x-y)}Sr_xSm_yO$	Sm-, Sr-doped NiO with *x* mole fraction of Sr and *y* mole fraction of Sm
PZT	Lead Zirconium Titanate
PMN	Lead Magnesium Niobium
PLZT	Polarised Lead Zirconium Titanate
SEM	Scanning Electron Microscope
SSA	Specific Surface Area
TGA/DSC	Thermogravimetric Analysis/ Differential Scanning Calorimetry
XRD	X-ray Diffraction
XRF	X-ray Fluorescence

LIST OF SYMBOLS

mol.%	mole percentage
vol.%	volume percentage
T	Temperature
s	Second
min	Minutes
h	Hours
V	Voltage
n	order of reflection
Ø	Diameter
θ	scattering angle
λ	Wavelength
ρ	Density
t	tolerance factor
ε_r	Dielectric constant
$\tan \delta$	Dielectric loss

KESAN PENDOPAN STRONTIUM DAN SAMARIUM TERHADAP SIFAT-SIFAT DIELEKTRIK NICKEL OKSIDA

ABSTRAK

Nikel oksida (NiO) telah menarik perhatian ramai penyelidik untuk mengkaji kegunaannya dalam aplikasi seperti filem elektrokromik, pemangkin, penderia gas, diod dan sebagainya. Ini disebabkan oleh sifatnya yang mempunyai kestabilan kimia, elektrik dan optik yang tinggi. Dalam kajian ini, kesan bahan dop ion strontium (Sr^{2+}) dan ion samarium (Sm^{3+}) ke atas sifat-sifat dielektrik NiO dikaji. Sifat-sifat dielektrik yang dikaji ialah pemalar dielektrik, ε_r dan kehilangan dielektrik, tan δ. Sistem elektroseramik $Ni_{(1-x)}Sr_xO$, $Ni_{(1-x)}Sm_xO$ dimana x = 0.01 sehingga 0.10 mol.% dan $Ni_{(1-x-y)}Sr_xSm_yO$, dimana x = 0.03, y = 0.01 sehingga 0.10 mol.% telah dihasilkan melalui kaedah tindak balas keadaan pepejal. Sampel telah disinter pada suhu 1200 °C (3 jam tempoh rendaman). $Ni_{(1-x)}Sr_xO$ disinter pada suhu 1100 sehingga 1300 ºC (1, 3, 6 and 10 jam tempoh rendaman). Suhu pensinteran 1200 ºC dengan tempoh rendaman selama 3 jam telah dikenalpasti sebagai parameter pensinteran yang optimum dalam pembentukan $Ni_{(1-x)}Sr_xO$. Ujian pembelauan sinar x-ray (XRD) ke atas sampel yang disinter menunjukkan pembentukan fasa $Ni_{(1-x)}Sr_xO$, $Ni_{(1-x)}Sm_xO$ dan $Ni_{(1-x-y)}Sr_xSm_yO$. Pemerhatian menggunakan mikroskop imbasan elektron pancaran medan (FESEM) ke atas sampel $Ni_{(1-x)}Sr_xO$ menunjukkan saiz butiran $Ni_{(1-x)}Sr_xO$ semakin membesar dengan peningkatan suhu pensinteran dan tempoh rendaman. FESEM diulang untuk $Ni_{(1-x)}Sm_xO$ dan $Ni_{(1-x-y)}Sr_xSm_yO$. Ketiga-tiga sistem menunjukkan saiz butiran semakin besar dengan penambahan bahan dop. Ketumpatan $Ni_{(1-x)}Sr_xO$, $Ni_{(1-x)}Sm_xO$ dan $Ni_{(1-x-y)}Sr_xSm_yO$ semakin meningkat dengan penambahan bahan dop Sr^{2+} dan Sm^{3+}, dan keliangan semakin menurun dengan

peningkatan kepekatan bahan dop (x, y). Sifat-sifat dielektrik diukur pada julat frekuensi (1 sehingga 1000 MHz). Peningkatan ε_r dikaitkan dengan penurunan tan δ. Komposisi optimum bagi $Ni_{(1-x)}Sr_xO$ dan $Ni_{(1-x)}Sm_xO$ dapat dilihat pada sampel *x* bersamaan 0.03 dan 0.05 mol.% dengan ε_r (3.24 x 10^3 dan 4.85 x 10^3) tertinggi dan tan δ (1.42 dan 0.19) terendah pada 1 MHz. Komposisi optimum untuk $Ni_{(1-x-y)}Sr_xSm_yO$ adalah pada sampel *y* bersamaan 0.03 mol.% dengan ε_r (5.41 x 10^3) tertinggi dan tan δ (0.13) terendah pada 1 MHz.