Synthesis and Characterizations of Substituted Ceramic Multiferroics

Thesis submitted in partial fulfillment for the
Award of the Degree

Doctor of Philosophy

By

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I, ***"Priyanka Verma"*** certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of ***"Dr. P.K. Roy"*** from ***"July 2015"*** to ***"July 2022"*** at the ***"Department of Ceramic Engineering," Indian Institute of Technology, Banaras Hindu University, Varanasi***. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any other's work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports, dissertations, thesis, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

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Priyanka Verma

List of Figures

List of Tables

List of Symbols and Abbreviations

Notation	Abbreviations
et al.	et alia, Latin for “and others “
i.e.	That is
e.g.	Example
etc.	Et cetera, Latin for “and other similar things”
Fig.	Figure
UV	Ultra-violet
mg	Milligram
g	Gram
cm	Centimeter
Hz	Hertz
min	Minute
h	Hour
BFO	Bismuth ferrite
s^{-1}	Per Second
SCLC	Space charge limited conduction
viz.	Namely
IR	Infrared
XRD	X-ray diffractometer
SEM	Scanning electron microscopy
MPMS	Magnetic property measurement system
FESEM	Field emission scanning electron microscopy
MHz	Megahertz
RT or rt	Room temperature
EDX	Energy dispersive X-ray spectroscopy
SQUID	Superconducting quantum interference device
ZFC	Zero field cooled
FC	Field cooled
VSM	Vibrating sample magnetometer
P-E	Ferroelectric hysteresis loop
MH	Magnetic hysteresis loop
Approx..	Approximate
Equiv.	Equivalent
FWHM	Full width half maxima

M’	Real electrical modulus
M’’	Imaginary electrical modulus
JCPDS	Joint Committee on Powder Diffraction Standards
XPS	X-ray Photoelectron Spectroscopy
R_F^2	(Structure R factor) ^{2}
E	Applied Electric field
D	Average crystalline size
T_{irr}	Blocking or Irreversible temperature
R_b	Bragg factor
H_c	Coercive field
T_c	Curie temperature
FM	Ferromagnetic
J	Leakage current density
d_{33}	Piezoelectric coefficient
PVA	Polyvinyl Alcohol
P	Polarization vector
T	Temperature
H	Magnetic field
M	Magnetization
M_s	Saturation magnetization
H_c	Coercivity
M_r	Remanent magnetization
T_N	Ne’el temperature
Y^{obs}	Observed profile
Y^{cal}	Calculated profile
R_p	Profile residual factor
R_{wp}	Weight profile residual factor
R_{exp}	Expected profile residual factor
R	Resistance
C	Capacitance
a, b, c	Lattice parameters
j	Joule
J	Current density
E_a	Activation energy
K	Kelvin
i,j,k,l	spatial coordinates
k	kilo

Symboles used	
Symboles	**Full name**
α	Slope of curves
β	Full width half maxima
°C	Degree Celsius
K	Kelvin
σ	Conductivity
©	Copyright
χ^2	Chi square
δ	Delta
>	Greater than
<	Less than
%	Percentage
Å	Angstrom
λ	Wavelength
&	And
π	Pi
±	Either plus or minus
≤ and ≥	Greater and Smaller- Than equal to
ω	Omega
χ	Magnetic susceptiblity
μ_{eff}	Effective magnetic moment
ε	Dielectric permittivity
θ	Bragg's angle
μ_s	Spin magnetic moment
ν	wavenumber
I_e	Ionisation energy
K_B	Boltzmann constant
R_c	Richardson constant
c	Velocity of light
C	capacitance
∈	microstrain
∋	strain