Hanoi University of Science - Vietnam National University

Hanoi International Symposium on Advanced Materials and Devices

January 10-12, 2019

Hanoi, Vietnam

P1-FPM: The influence of ball milling on crystal structure and magnetic properties of $(Fe_{1-x}Mn_x)_{75}P_{15}C_{10}$ alloy ribbons, *M. A. Islam, Bangladesh University of Engineering and Technology, Bangladesh*

P2-FPM: Influence of pH on the structure, morphology and properties of Fe_3O_4/Ag hybrid nanoparticles, *Chu Tien Dung, University of Transport and Communications, Vietnam.*

P3-FPM: Eco-friendly synthesis Silver nanoparticles using lemon extract and rice vinegar, *Cao Xuan Truong, Hanoi University of Science and Technology, Vietnam*

P4-FPM: Pressure induced modifications of the magnetic order in the spin chain compound $Ca_3Co_2O_6$, N. T. Dang, *Duy Tan University, Vietnam*

P5-FPM: Study of structure, optical, ferroelectric and ferromagnetic properties of Gd-doped $BiFeO_3$ materials, *Dao Viet Thang, Hanoi University of Mining and Geology, Vietnam*

P6-FPM: Comparative study of Na and K doping on local structure and critical temperature of (Bi, Pb)-2223 superconductor, *Jun-yung Oh, Chungbuk National University, South Korea*

P7-FPM: Influence of Co and Al on the magnetic properties and magnetocaloric effect of (Ni,Co)-Mn-(Sn,Al) Alloys, *Kieu Xuan Hau, Chungbuk National University, South Korea*

P8-FPM: Magnetic and electrical properties of $(La_{0.7}Sr_{0.3}Mn_{0.98}Co_{0.02}O_3)_{1-x}(La_2NiO_4)_{0.9}(BaTiO_3)_{0.1}]_x$ (x = 0.0; 0.1; 0.2; 0.3; 0.4) composites, *Le Thi Anh Thu, VNU-University of Science, Vietnam*

P9-FPM: Temperature dependent magnetic properties and domain observation of CoFeB/Pd multilayers, *Lin Huang, Chungbuk National University, South Korea*

P10-FPM: Hydrothermal synthesis and optical properties of in-situ Gr@WO_3-nanorod hybrid material, *Nguyen Cong Tu, Hanoi University of Science and Technology, Vietnam*

P11-FPM: Influence of Cr-concentration on magnetic properties and magnetocaloric effect of Fe-Cr-Gd-Zr-B rapidly quenched alloys, *Nguyen Hai Yen, Vietnam Academy of Science and Technology, Vietnam*

P12-FPM: Structural and magnetic properties of chromium-subsituted nickel ferrite synthesized by Sol-Gel method, *Nguyen Le Thi, Chungbuk National University, South Korea*

P13-FPM: Cu_2O nanoparticles: A simple synthesis, characterization and its photocatalytic performance toward Methylene Blue, *Nguyen Thi Tuyet Mai, Hanoi University of Science and Technology, Vietnam*

P14-FPM: Density functional studies of the adsorption of CO on TiO_2 anatase surfaces, *Nguyen Tien Cuong, VNU-University of Science, Vietnam*

P15-FPM: Photo-thermal conversion characteristics of Carbon nanotubes dispersion in Bitumen for direct solar thermal energy absorption applications, *Nguyen Trong Tam, Vietnam Academy of Science and Technology, Vietnam*

P16-FPM: Study on crystal structure and magnetic properties of $La_{0.8}R_{0.2}(Fe_{0.88}Si_{0.12})_{13}$ (R = Y, Sm, Tb, Ho and Yb) alloys, *Vuong Van Hiep, VNU-University of Science, Vietnam*

P17-FPM: Structural, magnetic and magneto-caloric properties of $MnFeSi_{0.25}P_{0.75-x}Ge_x$(x =0.08, 0.1, and 0.12) intermetallic compounds, *T. H. Mollah, Bangladesh University of Engineering and Technology, Bangladesh*

P18-FPM: Magnetic properties in $La_{0.7}Ca_{0.3-x}Sn_xMnO_3$ ($0 \leq x \leq 0.1$) compounds with a second-order phase transition, *Wen-Zhe Nan, Chungbuk National University, South Korea*

P19-FPM: Influence of Pr-doping on magnetic properties and magnetocaloric effect of $La_{1-x}Pr_xSr_{0.3}MnO_3$ compounds (x = 0, 0.3, 0.5, 0.7), *Yen Pham, Chungbuk National University, South Korea*

P20-FPM: Magnetocaloric effect in Gd_2O_3 nanofibers, *Yen Pham, Chungbuk National University, South Korea*

P21-FPM: Magnetic and magnetocaloric properties of polycrystalline $Pr_{0.7}Ba_{0.1}Sr_{0.2}MnO_3$, *Yen Pham, Chungbuk National University, South Korea*

P22-FPM: Synthesis and characterization of magnetic properties of nanocrystalline perovskite $Eu_{1-x}La_xFeO_3$ (x = 0.0 – 1.0), *Nguyễn Thị Thủy, Hue University, Vietnam*

P23-FPM: EXAFS cumulant investigation of thermal disorder in iron monosilicide alloy, *Nguyen Thi Hong, Hong Duc University, Vietnam*

P24-FPM: Effect of Na-substitution on the ordering of Cu-O layer and interlayer coupling of the $Bi_{1.6}Pb_{0.4}Sr_2Ca_{2-x}Na_xCu_3O_{10+\delta}$ superconducting system, *Jun-yung Oh, Chungbuk National University, Korea*

P25-FPM: Monte Carlo simulation for the Shastry-Sutherland lattice with disorder, *Oanh K. T. Nguyen, Vietnam National University, Vietnam*

P26-FPM: A DFT – based study on the structure and electronic properties of $LaGaO_3$ – based perovskite, *Nguyen Hoang Linh, Hanoi University of Science and Technology, Vietnam*

P1-AMD: Multifunctional Fe_3O_4-ZnO nanocomposites: synthesis and properties for applications in wastewater treatment, *Doan Thi Thuy Phuong, University of Transport and Communications, Vietnam*

P2-AMD: Lipid monolayer: a promising candidate for gate dielectric in bioFETs and biosensors, *T. Tan Do, IMET - Nacentech, Vietnam*

P3-AMD: Half-Heusler HfCoSb alloy: a novel material for Thermoelectric applications, *D. P. Rai, Pachhunga University College, India*

P4-AMD: Multichannel smartphone based spectrometer and its application in analyzing enhancement of photocatalytic degradation of methyl blue by Zinc Oxide nanorods, *Hanh Hong Mai*, *VNU-University of Science, Vietnam*

P5-AMD: Optimizing oriented anti-AFP on screen-printed carbon electrode in developing immunobiosensor for AFP antigen detection, *T.N.-Lien Truong, Hanoi University of Science and Technology, Vietnam*

POSTER PRESENTATION LIST

P6-AMD: Electrochemical synthesis of flower-like gold nanoparticles for SERS application, *Luong Truc Quynh Ngan, Vietnam Academy of Science and Technology, Vietnam*

P7-AMD: Front-end circuit design for multiplication point kP (233-bit) based on elliptic curve algorithm, *Luc Nhu Quynh, Hanoi University of Science and Technology, Vietnam*

P8-AMD: Visible light induced photocatalytic degradation of Rhodamine B of Ni-doped TiO_2 nanocrystalline powders, *Luong Huu Bac, Ha Noi University of Science and Technology, Vietnam*

P9-AMD: Fabrication of WO_3/MWCNTs hybrid nanomaterials for room temperature NH_3 gas sensors, *Nguyen Huu Lam, Hanoi University of Science and Technology, Vietnam*

P10-AMD: Staphylococcus aureus behaviors in the citric acid environment using a 3D printed AFM fluid cell, *Nguyen Thi Phuong Linh, National Cheng Kung University, Taiwan*

P11-AMD: Photocatalyst of ZnO nanorods decorated with Au nanoparticles, *Tran Thi Ha, University of Mining and Geology, Vietnam*

P12-AMD: Chemical sensing by surface enhance Raman scattering on ZnO nanorods decorated with gold nanoparticles, *Tran Thi Ha, University of Mining and Geology, Vietnam*

P13-AMD: Influence of ZnO nanorods on sensitivity of wireless passive LC temperature sensor fabricated by printed circuit board (PCB), *Pham Van Thanh, VNU-University of Science, Vietnam*

P14-AMD: Study of microwave absorption properties of manganese-nickel-zinc ferrite – reduced graphene oxide – polyaniline nanocomposite, *Tran Quang Dat, Le Quy Don Technical University, Vietnam*

P15-AMD: A label-free DNA sensor based on a microcantilever platform, *Thi Thuong Trinh, National Center for Technological Progress, Vietnam*

P16-AMD: Fabrication of molecularly imprinted polyaniline based electrochemical sensor towards the detection of antibiotic residue, *Van Phu Vu, National Center for Technological Progress, Vietnam*

P17-AMD: Magnetocaloric microwires for energy-efficient magnetic refrigeration, *N.T.M. Duc, VNU-University of Science, Vietnam and University of South Florida, USA*

P18-AMD: Stability mechanism of perovskite solar cell, *Quang-Duy Dao, VNU – University of Science, Vietnam*

P19-AMD: A newly designed ferromagnetic microwire solenoid sensor for motion tracking and biosensing applications, *Lam Son Dao, University of South Florida, Tampa, USA*

P20-AMD: Characterization on Cu doped ZnO thin films prepared by solution processing, *Le Thi Hien, VNU-Vietnam Japan University, Vietnam*

P1-NM: On-chip growth of tin oxide nanowires DNA sensor, *Hieu M. Nguyen, VNU-University of Science, Vietnam*

P2-NM: Synthesis and properties of superparamagnetic–plasmonic nanoparticles Fe_3O_4@SiO_2-Au for applications in biomedicine, *Phi Thi Huong, VNU-University of Science, Vietnam*

P3-NM: The effect of potential applied on magnetic nanoparticles fabrication process by sonoelectrodeposition method, *Vu Thi Huyen Trang, Vietnam National University, Vietnam*

P4-NM: Optical properties of ZnSe nanoparticles, *Tran Thi Kim Chi, Institute of Materials Science, Vietnam*

P5-NM: Synthesis of ZnSe nanocrystals by hydrothermal method for solid lighting, *Bui Thi Thu Hien, Institute of Materials Science, Vietnam*

P6-NM: Preparation and magnetic properties of cylindrical permalloy nanowires, *Yunxiu Zhao, Chungbuk National University, Republic of Korea*

P7-NM: Functional integral method for a ferromagnetic honeycomb monolayer, *Pham Huong Thao, Hue University, Vietnam*

P8-NM: Effect of ZnO on magnetic interaction of Fe_3O_4/ZnO core/shell nanocomposites, *To Thanh Loan, Hanoi University of Science and Technology, Vietnam*

P9-NM: Phase-Pure Brookite TiO_2 as a highly active photocatalyst for the degradation of pharmaceutical pollutants, *Tran Thi Thuong Huyen, Institute of Materials Science, Vienam*

P10-NM: Biometamaterial: A dark ultrathin copper film based on Pistia Stratiotes, *Pham Dinh Dat, VNU-Vietnam Japan University, Vietnam*

P11-NM: Biometamaterials: black untrathin copper film fabricated on purple bauhinia, *Dao Trung Duc, VNU-Vietnam Japan University, Vietnam*

P12-NM: Effective Anisotropic Media for Plasmonic core-shell Au-Cu_2O Nanoparticles, *Sai Cong Doanh, VNU-University of Science, Vietnam*

P13-NM: Synthesis and Characterizations of TiO_2:Mn_{2+} Nanoparticles, *Trinh Thi Loan, VNU-University of Science, Vietnam*

P14-NM: Detection of carbendazim by SERS technique with SiO_2 ordered structures and silver nanoparticles, *Nguyen Duy Thien , VNU-University of Science, Vietnam*

P15-NM: Fabrication of SERS substrates base on porous Si nanostructures and metal nanoparticles and their application in detection of carbendazim, *Nguyen Duy Thien, VNU-University of Science, Vietnam*

P16-NM: Photo-Dynamic Properties of CdSe/CdS Quantum Dots in Intra-Cellular Media, *Thanh Binh Nguyen Institute of Physics, Vietnam*

STUDY OF STRUCTURE, OPTICAL, FERROELECTRIC AND FERROMAGNETIC PROPERTIES OF Gd-DOPED $BiFeO_3$ MATERIALS

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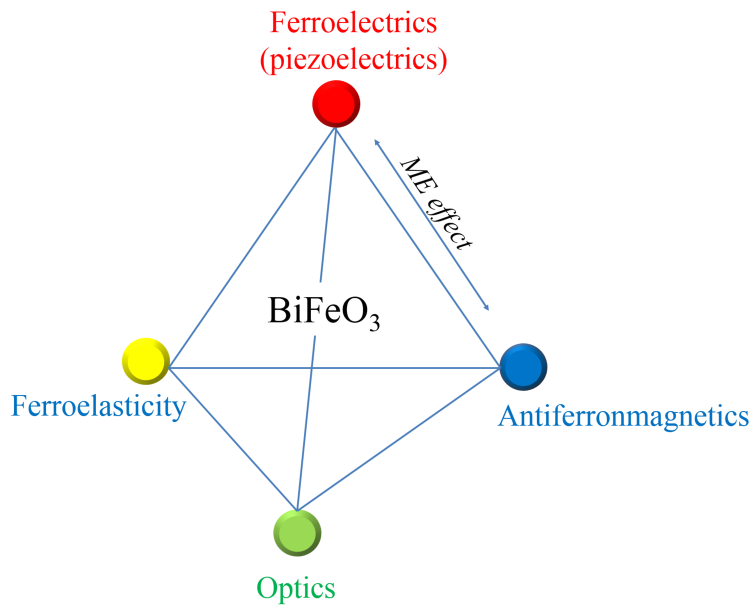
INTRODUCTION

- Multiferroic $BiFeO_3$ (BFO) materials exhibit simultaneous presence of ferroelectricity (T_C ~ 1100 K), antiferromagnetism (T_N ~ 640 °C) and ferroelasticity in one structure phase.
- Applications in data storage, spintronic and microelectronic device, and possibility of controlling magnetic order by electrical field or vice verse through magnetoelectric coupling.
- Our report shows that Gd-doped $BiFeO_3$ affect on structure, optical, ferroelectric, and ferromagnetic properties.



EXPERIMENTAL

- $Bi_{1-x}Gd_xFeO_3$ (x = 0.00 ÷ 0.15) materials in our investigation were prepared by a sol-gel method
- The chemicals using: $Bi(NO_3)_3.5H_2O$, $Fe(NO_3)_3.9H_2O$, $Gd(NO_3)_3.6H_2O$, ethylene glycol, and citric acid.
- The obtained samples were characterized by using different techniques: X-ray diffraction, Raman scattering, EDX spectra, absorption spectroscopy, SEM images, magnetization hysteresis loops, polarization electric hysteresis loops.

RESULTS AND DISCUSSION

Structure

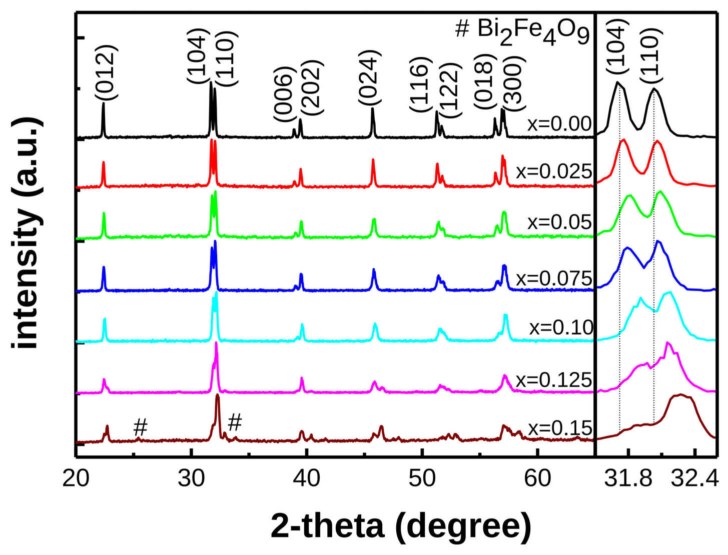


Fig. 1. X-ray diffraction diagrams of $Bi_{1-x}Gd_xFeO_3$ (x = 0.00 ÷ 0.15) powder

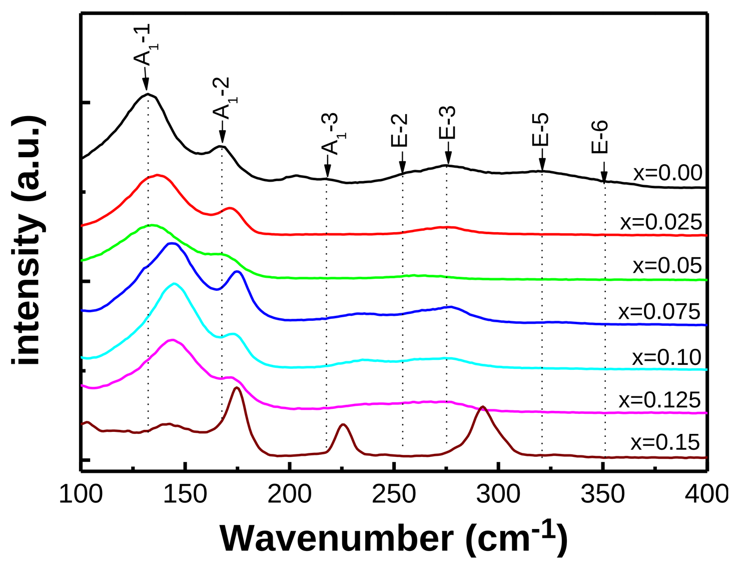


Fig. 2. Raman scattering spectra of $Bi_{1-x}Gd_xFeO_3$ (x = 0.00 ÷ 0.15) powder

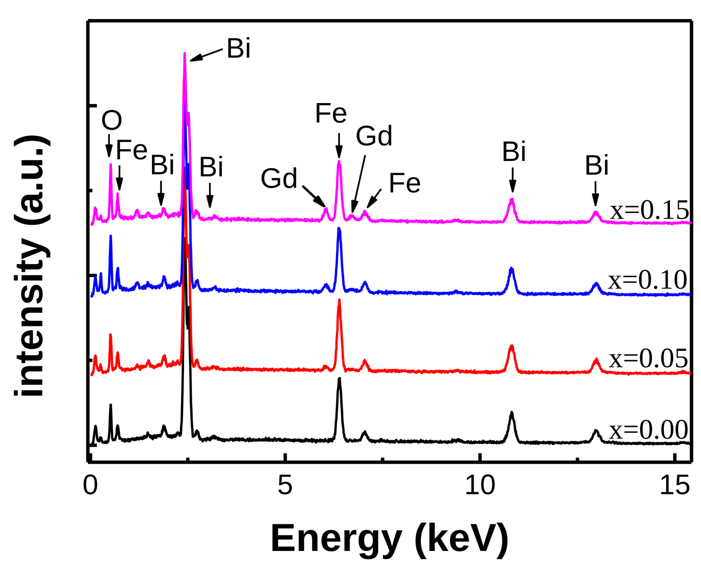


Fig. 3. EDX spectra of $Bi_{1-x}Gd_xFeO_3$ (x = 0.00, 0.05, 0.10, and 0.15) powder

- $Bi_{1-x}Gd_xFeO_3$ (BGFO) materials can be indexed based on rhombohedral phase BFO to agree JPCDS card No. 71-2494. The crystal lattice parameters and crystalline size of Gd-doped samples tend to narrow compare with pure BFO.
- Analysising XRD, Raman, EDX show that the concentration of Gd increases from x =0.00 to x = 0.125 , Gd^{3+} was well-dissolved in BFO material to form a single-phase followed the crystal structure of the host BFO. The structural transformation from rhombohedral to orthorhombic when concentration of Gd increases up to x = 0.15

Morphology surface

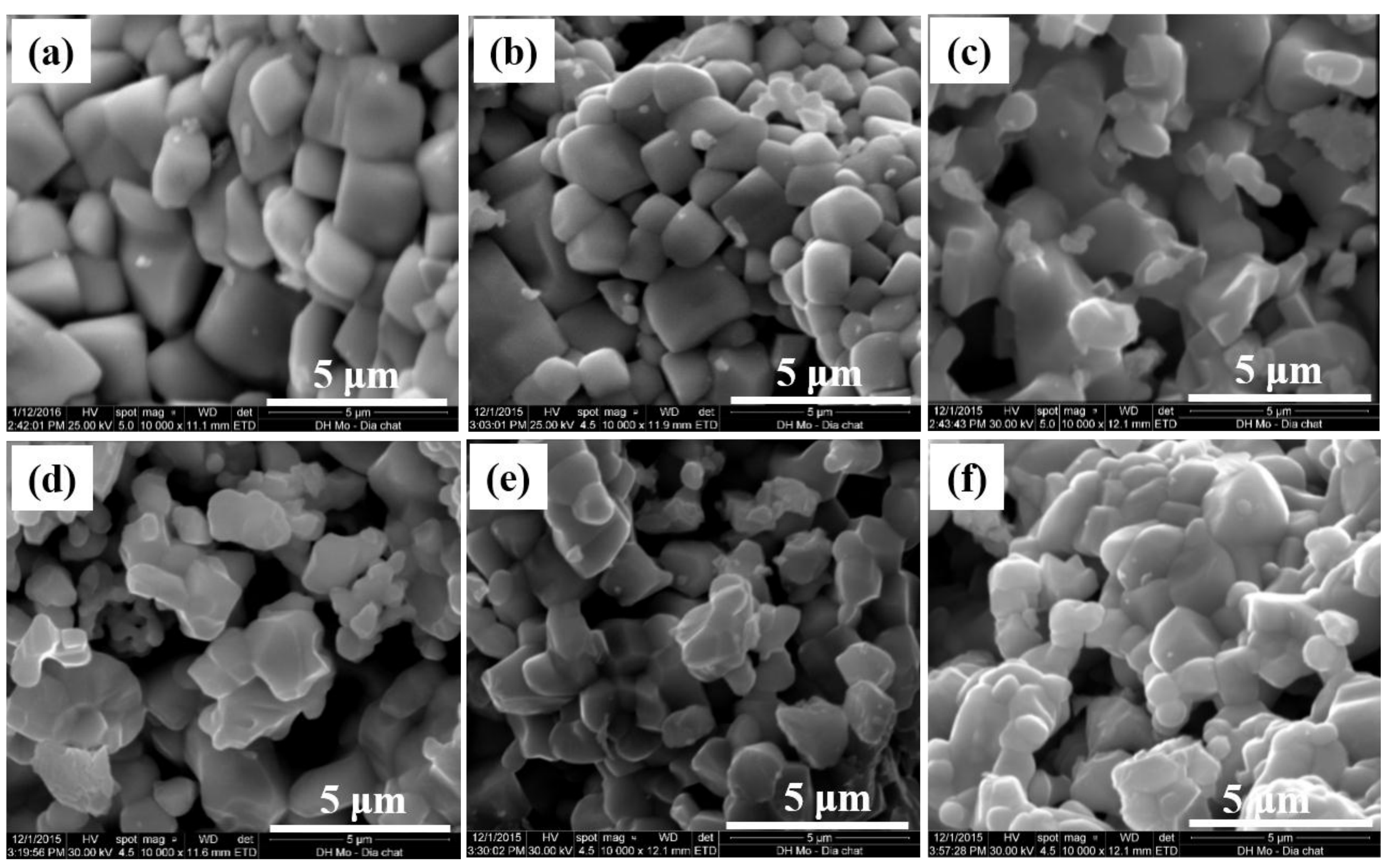


Fig. 4. SEM images of $Bi_{1-x}Gd_xFeO_3$ powder (a) x = 0.00; (b) x = 0.025; (c) x = 0.05; (d) x = 0.075; (e) x = 0.10; (f) x = 0.15

- Gd-doped $BiFeO_3$ sample with x = 0.00, the grains are homogeneous with the size average of 2 µm, as shown in Fig. 4a.
- Gd-doped $BiFeO_3$ sample with x = 0.025, the grains become inhomogeneous, where many smaller grains are appeared alternating the 2 µm size grains.
- The increase of concentration of Gd^{3+} ions in the samples, the grains become more homogeneous with smaller size, below 1 µm.

Acknowledgments: This research is funded by Ministry of Education and Training of Vietnam grant number B2018-MDA-02-CtrVL.

Optical properties

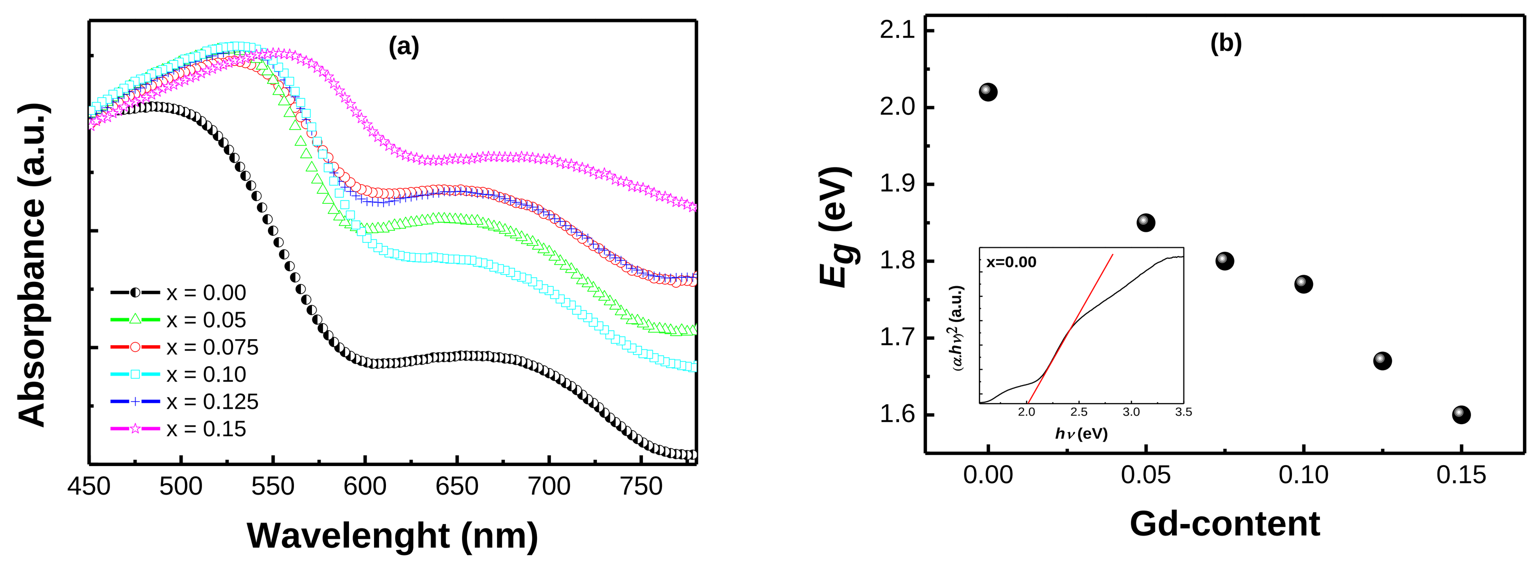


Fig. 5. (a) Absorption spectroscopy of $Bi_{1-x}Gd_xFeO_3$ powder; (b) Dependent of optical band gap of $Bi_{1-x}Gd_xFeO_3$ materials on concentration of Gd.

- E_g decreases from 2.02 to 1.60 eV as concentration of Gd increases from 0.00 to 0.15
- The absorption edge at 500 ÷ 600 nm position happens when the electron is excited from O-p states to Fe-d states. The absorbance at 700 nm position may be related to minor absorption happens when the electron is excited from t_{2g} bands to e_g bands.

Magnetics properties

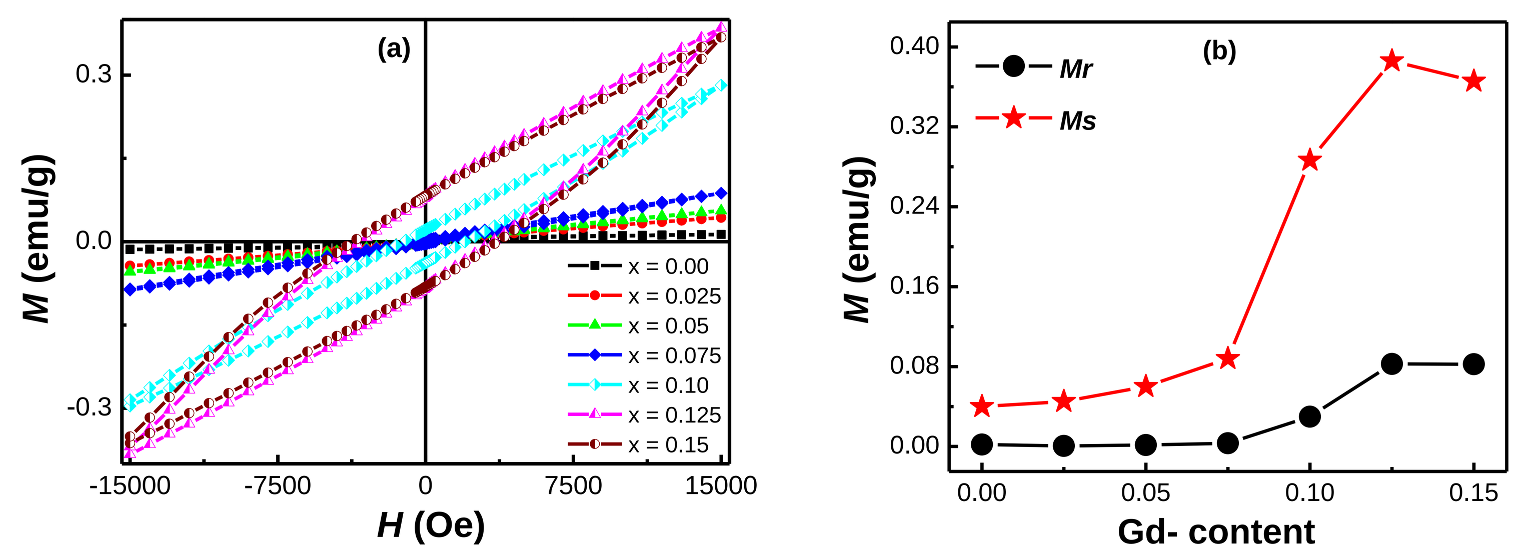


Fig. 6. (a) Magnetic hysteresis loops of the $Bi_{1-x}Gd_xFeO_3$ powder at room temperature; (b) Dependent of magnetization of $Bi_{1-x}Gd_xFeO_3$ on concentration of Gd

- The enhancement of magnetization of the doped $BiFeO_3$ materials may be ascribe to three aspects: (i) the increase of the spin canting angle resulting in the net macroscopic magnetization; (ii) the suppressionn of spiral structure; (iii) the increase in spin canting due to the change in bond ange of Fe-O-Fe

Ferroelectric properties

- The ferroelectric are clearly improved in Gd-doped samples with concentration of Gd x = 0.05 and 0.10 compare to that of BFO samples. When concentration of Gd increases up to x = 0.15, the ferroelectric property is reduced campare to that of BFO sample.
- Gd-doped BFO with concentration of Gd x = 0.10 shows the P_s and P_r values, indicating the best improvement of ferroecletric properties.

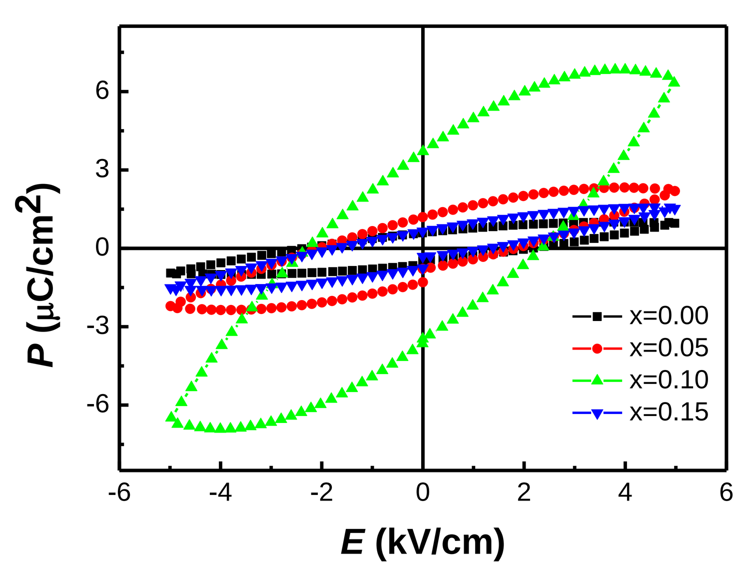


Fig. 7. Ferroelectric hysteresis loops of $Bi_{1-x}Gd_xFeO_3$ powder.

CONCLUSIONS

- $Bi_{1-x}Gd_xFeO_3$ materials were synthesized using sol-gel method. The crystalline structure, optical, ferromagnetic, and ferroelectric properties of $B_{1-x}Gd_xFeO_3$ materials were investigated
- The concentration of Gd increases from x = 0.00 to x = 0.125, all these samples possessed a rhombohedral structure phase. While concentration of Gd increases up to x = 0.15, this sample possessed both rhombohedral and orthorhombic structure phases.
- The Gd-doping has made the disortion of structure, decreased lattice parameters, grain size, and optical band gap. We found that Gd-doping with concentration of Gd increases from x = 0.10 to x = 0.125 can improve both ferromagnetism and ferroelectricity of $BiFeO_3$ materials.