VIETNAM NATIONAL UNIVERSITY, HANOI
VNU UNIVERSITY OF ENGINEERING AND TECHNOLOGY

SOCIALIST REPUBLIC OF VIETNAM
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INFORMATION ON DOCTORAL THESIS

1. Full name: Nguyen Dang Co 2. Sex: Male
3. Date of birth: 05/01/1995 4. Place of birth: Hung Yen, Vietnam
5. Admission decision number: Decision No. 1200/QĐ-CTSV dated December 29, 2020, issued by the Rector of the VNU University of Engineering and Technology (UET), Vietnam National University, Hanoi (VNU).
6. Changes in academic process: Decision No. 2029/QĐ-ĐHCN dated September 22, 2025, issued by the Rector of UET regarding the change of the dissertation title.
7. Official thesis title: Study on the fabrication and characterization of some micro–nano structured dielectric/Fe_3O_4 composite materials oriented for applications in energy storage and electromagnetic wave absorption.
8. Major: Nano-Materials and Devices 9. Code: 9440126.01QTD
10. Supervisors:
- Principal Supervisor: Assoc. Prof. Dr. Pham Duc Thang, VNU University of Science
- Co-supervisor: Dr. Bui Dinh Tu, VNU University of Engineering and Technology

(According to Decision No. 98/QĐ-ĐT dated February 3, 2021, issued by the Rector of UET)
11. Summary of the new findings of the thesis:

a. Research objectives:

- To fabricate a series of micro–nano structured dielectric/magnetic composite materials based on lead-free perovskite dielectrics such as $BaTiO_3$ (BTO) and $Bi_{0.5}(Na_{0.8}K_{0.2})_{0.5}TiO_3$ (BNKT) combined with spinel ferrite Fe_3O_4, using selected chemical and physical methods.
- To design and evaluate the energy storage capability and electromagnetic (EM) wave absorption properties of the fabricated composite materials.

b. Research content and methodology:

- Material synthesis: Preparation of individual oxide particles (BTO, Fe_3O_4, BNKT) with micro–nano sizes using microwave-assisted hydrothermal, co-precipitation, and sol–gel methods. Fabrication of micro–nano structured dielectric/magnetic composites by wet ball milling (BTO–Fe_3O_4, BNKT–Fe_3O_4) and a two-step co-precipitation process (BNKT@Fe_3O_4).
- Characterization: Investigation of crystal structure, morphology, composition, and chemical bonding using XRD, Raman, and SEM–EDX techniques; and analysis of optical and magnetic properties using UV–Vis and VSM measurements.

- Experimental evaluation: Design and fabrication of dielectric ceramic capacitors using BTO–Fe_3O_4 and BNKT–Fe_3O_4 composites, followed by evaluation of dielectric, ferroelectric, and energy storage properties using LCR and Sawyer–Tower systems. Fabrication of EM wave absorber samples based on BNKT@Fe_3O_4 composites and analysis of absorption characteristics using a vector network analyzer.

c. Main contributions of the dissertation:

- Successfully fabricated several micro–nano structured dielectric/Fe_3O_4 composite materials, including (1–*x*)BTO–*x*Fe_3O_4 (*x* = 0, 0.5, 1, and 3 wt%), (1–*y*)BNKT–*y*Fe_3O_4 by wet ball milling (with BTO, BNKT, and Fe_3O_4 powders synthesized via microwave-assisted hydrothermal, sol–gel, and co-precipitation methods), and *m*BNKT@(1–*m*)Fe_3O_4 (*m* = 10, 20, 30, and 50 wt%) via a two-step sol–gel and co-precipitation route. Their structural and functional characteristics were systematically investigated.

- Dielectric ceramic capacitors and electromagnetic (EM) wave absorber samples were designed, fabricated, and tested using micro–nano structured dielectric/Fe_3O_4 composite materials. Specifically: (*i*) The (1–*x*)BTO–*x*Fe_3O_4 ceramic capacitor with *x* = 0.5 wt% exhibited a dielectric constant of 1983.17 at 1 MHz, a low dielectric loss of 0.04, and an energy storage efficiency of 73%; (*ii*) The (1–*y*)BNKT–*y*Fe_3O_4 ceramic capacitor with *y* = 0.5 wt% showed a high dielectric constant of 793.8 with low dielectric loss of 0.04 at 1 MHz and a high energy storage efficiency of 86.4%. The *m*BNKT@(1–*m*)Fe_3O_4 composite with *m* = 50 wt% and a thickness of 3.3 mm achieved an effective electromagnetic wave absorption efficiency of 99.95% at 12.24 GHz, corresponding to a wide absorption bandwidth of 4.77 GHz.

12. Practical applicability, if any:

13. Further research directions, if any: Further studies and experimental evaluations of the energy storage and electromagnetic wave absorption capabilities of the composite materials.

14. Thesis-related publications: 07

[1]. **Co Dang Nguyen**, Duong Xuan Nguyen, Hung Duy Tran, Thanh Van Hoang, Thang Van Pham, Quan Duc Ngo, Tiep Huy Nguyen, Viet Quoc Dong, Ha Tran Nguyen, Lam Dinh Nguyen, Long The Phan, Dung Duc Dang, Tu Dinh Bui, Thang Duc Pham, "*Influence of Calcination Temperature on Characteristics of $Bi_{1/2}(Na_{0.8}K_{0.2})_{1/2}TiO_3$ Powders and Dielectric Properties of Ceramics by Sol-Gel Method*", (**2025**), Journal of Electroceramics. Doi: 10.1007/s10832-025-00422-z.

[2]. **Co Dang Nguyen**, Viet Quoc Dong, Hung Duy Tran, Vu Quang Dinh, Lan Thi Nguyen, Vinh Huu Dang, Canh Tuan Nguyen, Giang Thi Huong Do, Long The Phan, Quan Duc Ngo, Thang Van Phang, Dung Duc Dang, Tu Dinh Bui, Thang Duc Pham, "*Fabrication process of ceramic capacitor derived from lead-free $Bi_{0.5}(Na_{0.8}K_{0.2})_{0.5}TiO_3$ bulk and powder synthesized via sol-gel method*", (**2025**), Applied Physic A, V 131 (36). Doi: 10.1007/s00339-024-08162-7.

[3]. Tran Duy Hưng, **Nguyen Dang Co***, Ho Thi Anh, Dang Huu Vinh, Luong Viet Hoang, Ngo Duc Quan, Dang Duc Dung, Nguyen Thi Lan, Pham Duc Thang, Bui Dinh Tu, (**2024**) "*Study on Improving the Magnetic and Dielectric Properties of (1–x) $Bi_{0.5}(Na_{0.8}K_{0.2})_{0.5}TiO_3$–$xFe_3O_4$ Composites for Ceramic Capacitor Applications*" Proceedings of the 4th Student Forum on Frontiers in Sustainability, December 17, 2023, Hanoi, Vietnam, pp. 162–167.

[4]. **Nguyen Dang Co**, Bui Dai Phat, Phan Van Khai, Tran Quang Dat, Ho Thi Anh, Nguyen Tran Ha, Le Viet Cuong, Nguyen Huy Tiep, Nguyen Thi Minh Hong, Dang Duc Dung, Ngo Duc Quan, Tran Mau Danh, Phan The Long, Pham Duc Thang and Bui Dinh Tu, "*Synthesis and Microwave Absorption Properties of Novel $Bi_{1/2}(Na_{0.8}K_{0.2})_{1/2}TiO_3$ - Fe_3O_4 Composite*", (**2023**), Materials Transactions, V. 64, 10, pp. 2450-2456. Doi:10.2320/matertrans.MT-MG2022026.

[5]. **Nguyen Dang Co**, Tran Quang Dat, Nguyen Tran Ha, Dang Duc Dung, Nguyen Thi Lan, Mai Duc Dung, Ngo Duc Quan, Bui Dinh Tu, Pham Duc Thang, "*Broadband Microwave Absorption Properties of Fe_3O_4-BNKT Composites in 2-18 GHz*", (**2023**), Proceedings of The 4th International Workshop on Advanced Materials and Devices (IWAMD 2023), August 10-13, 2023, Thai Nguyen, Vietnam, pp.245-250, ISBN: 978-604-350-270-1.

[6]. **Nguyen Dang Co**, Tran Duy Hung, Bui Dai Phat, Dang Duc Dung, Ngo Duc Quan, Nguyen Hai Binh, Do Thi Huong Giang, Tran Mau Danh, Bui Dinh Tu, Pham Duc Thang, "*Magnetic, Ferroelectric and Energy Storage Properties of Bismuth Sodium-Potassium Titanate Lead-Free Ceramic and Thin Film Prepared by Sol-Gel Method*", (**2023**), Proceedings of The 4th International Workshop on Advanced Materials and Devices, (IWAMD 2023), August 10-13, 2023, Thai Nguyen, Vietnam, pp. 227-233, ISBN: 978-604-350-270-1.

[7]. **Nguyen Dang Co**, Bui Thi Thu Thuy, Nguyen Thi Luong, Dong Quoc Viet, Le Viet Cuong, Dang Duc Dung, Ngo Duc Quan, Tran Mau Danh, Pham Duc Thang, Bui Dinh Tu, "*Synthesis, Characterization and Microwave Absorption Properties of Lead-Free $Bi_{0.5}(Na_{0.8}K_{0.2})_{0.5}TiO_3$ by Sol-Gel Method*", (**2022**), VNU Journal of Science: Mathematics – Physics, Vol. 38, No. 1, pp.76-87. Doi: 10.25073/2588-1124/vnumap.4665.