VIETNAM NATIONALUNIVERSITY, HANOI
VNUUNIVERSITY OF ENGINEERING AND TECHNOLOGY

SOCIALISTREPUBLIC OF VIETNAM
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INFORMATION ON DOCTORAL THESIS

1. Full name : Vu Xuan Manh2. Sex: Male

3. Date of birth: July 23, 19794. Place of birth: Thaibinh

5. Admission decision number:778/QĐ-CTSV Dated August 21, 2017

6. Changes in academic process: ....

- Decision on extending the study period for K24 PhD students (phase 1) No. 561/QD-DT, dated August 28, 2020 of the President of the University of Technology, Vietnam National University, Hanoi. The extension period is 2 years.
- Decision on returning PhD students to their locality/work agency No. 1179/QD-DT, dated November 29, 2022 of the President of the University of Technology, Vietnam National University, Hanoi.
- Adjustment of the PhD thesis title according to decision number: 1437/QĐ-ĐHCN dated July 15, 2024. The old thesis title, "Research, design, and fabrication of microfluidic chips with sensors based on MEMS technology and multifunctional nanoparticles for biomedical applications" has been changed to the new title, "Research, design, and fabrication of microfluidic chips with sensors based on MEMS technology and superparamagnetic nanoparticles oriented towards biomedical applications". This change better aligns with the thesis content and does not alter the research direction.

7. Official thesis title: Research, design, and fabrication of a microfluidic chip with integrated sensors based on MEMS technology and superparamagnetic nanoparticles, aimed at biomedical applications

8. Major: Electronic Engineering 9. Code: 9510302.01

10. Supervisors: Assoc.Prof. Ph.D Bui Thanh Tung; Prof. Ph.D. Chu Duc Trinh

11. Summary of the **new findings** of the thesis:

Objective of the study

The objective of this thesis is to research and develop a highly sensitive microfluidic measurement system to detect the concentration of superparamagnetic nanoparticles

(SPMNPs) in the continuous flow of a microfluidic chip, with the goal of developing a quantitative analysis system for SPMNP-labeled cells in continuous flow.

Research subjects: microfluidic chip with integrated magnetic sensors, microfluidic measurement system, signal processing circuit, and biologically functionalized SPMNPs.

Research Methods

The thesis combines methods including theoretical research, mathematical modeling, simulation, measurement, and experimental validation.

Main results and conclusions

- Proposed a model of a super-sensitive magnetic microfluidic measurement system to determine very low concentrations of superparamagnetic nanoparticles in the continuous flow of a microfluidic chip, which has the potential to develop a system for quantitative analysis of cells in continuous flow. This method can reduce the volume of the sample to be analyzed, avoid errors due to non-magnetic impurities, and take advantage of the marker as magnetic particles from the cell separation process.
- Successfully fabricated the proposed microfluidic measurement system, using industrial-grade 3D printing technology for the microfluidic chip. This innovative approach is novel in the thesis; the applied mathematical model for optimizing parameters is highly scientific and meets practical requirements. Additionally, signal processing techniques are compatible with the sensor's physical properties, which reduce the signal detection limit of the super-sensitive magnetic microfluidic measurement system to 3.81 nT, corresponding to a concentration of 12.5 μg/mL of superparamagnetic nanoparticles, better than the results of some previous studies.
- **Conclusion:** A magnetically sensitive microfluidic system has been successfully developed to determine very low concentrations of SPMNPs in continuous flow. This system has potential applications in biomedical analysis, reducing the cost of testing by streamlining procedures and minimizing the use of tracers, while avoiding errors from non-magnetic impurities.

12. Practical applicability, if any: The proposed system has the potential to be developed into a biomedical analysis system, which can reduce testing costs by reducing procedures and markers, while avoiding errors from non-magnetic impurities.

13. Further research directions, if any:

- Some samples of superparamagnetic nanoparticles that have been surveyed and meet the detection ability of the proposed measurement system need to be studied for their

biochemical functions to separate and enrich cells in the sample, then quantify cells using the proposed measurement system.

- The thesis product needs further development to be more compact, integrating the processes of separation, cell enrichment, and quantification into a single device to save time, reduce costs, simplify operations, and meet best practices.

14. Thesis-related publications:

1. **Xuan, Manh Vu**; Ngoc, Thao Pham; Bui, Tu Dinh; Quoc, Tuan Vu; Minh, Hieu Nguyen; Quang, Loc Do; Hai, Binh Nguyen; Duc, Trinh Chu; Thanh, Tung Bui (2021), "Real-time, continuous-flow determination of the magnetic nanoparticles concentration by modified-GMR sensor" *The 2nd Poland-Vietnam Symposium on Natural Science, High Technologies and Humanities for Young Scientists PolVietSym2021 (Cracow, Poland, November 20-21, 2021)*, 2, 83-84
2. **Xuan, Manh Vu**; Ngoc, Thao Pham; Quoc, Tuan Vu; Minh, Hieu Nguyen; Hoang, Nam Nguyen; Quang, Loc Do; Duc, Trinh Chu; Thanh, Tung Bui (2021), "Concentration Detection of Continuous-Flow Magnetic Nanoparticles Using Giant Magnetoresistance Sensor", 2*021 3rd International Symposium on Material and Electrical Engineering Conference (ISMEE)*, Vol. 3 (IEEE, (2021)), pp. 78–82.
3. **Xuan, Manh Vu**; Dang, Phu Nguyen; Quang, Loc Do; Minh, Hieu Nguyen; Duc, Trinh Chu; Thanh, Tung Bui (2022) "Highly sensitive modified giant magnetometer resistance measurement system for the determination of superparamagnetic nanoparticles in continuous flow with application for the separation of biomarkers"; Instrumentation Science & Technology; Volume 51, Issue 4, 382-399
4. **Vũ Xuân Mạnh**, Vũ Quốc Tuấn, Nguyễn Đăng Phú, Đỗ Quang Lộc, Chử Đức Trình, Bùi Thanh Tùng (2023), "Hệ đo siêu nhạy từ dựa trên kỹ thuật khuếch đại Lock-in và cảm biến từ trở khổng lồ (GMR)", Tạp chí Khoa học và Công nghệ Việt Nam.