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Report on the thesis of Lucie DUBOVSKÁ

***Essential Elements Towards the Development of Diamond-Based
Biosensors for Bacteria Detection in Water***

Presented in order to obtain the Degree of :
Doctor of Philosophy. (Ph.D.) of Czech Technical University in Prague
In the field of: *Biomedical and Clinical Technology*

Mrs. **Lucie DUBOVSKÁ** (born **DRBOHLAVOVA**) presents a thesis in which she describes her work on the development of Love wave-SAW (LW-SAW) biosensor with integrated CVD layer as an interface for the attachment of bacteriophage's tail fibers as bioreceptor for the bacteria detection in water. These biosensors aim to take advantage of the exceptional properties of diamond. The thesis project was conducted in combined Ph.D. study at the Department of Natural Sciences of the Faculty of Biomedical Engineering of the Czech Technical University in Prague under the supervision of Dr. Vincent MORTET from Institute of Physics, Czech Academy of Sciences and Prof. Abdelkrim TALBI from Institute of Electronics, Microelectronics and Nanotechnology, France.

The manuscript is organized into four chapters. In each chapter is dealt a clearly defined project where the targets are well pointed out and the results clearly presented. The conclusions are also clearly announced even when the results are not satisfactory. This shows the quality of the candidate's scientific approach and his honesty.

Mrs. **Lucie DUBOVSKÁ** start her manuscript through a chapter where she describes the motivation for her doctoral project and specifies the context of the study. She then continues and describes the contents of the 4 chapters constituting this manuscript.

In the first chapter, author conducted a theoretical study and examines the current state of whole-cell bacteria detection, including biosensors that use bacteriophages or bacteriophage tail fibers as bioreceptors. It then discusses acoustic-wave sensors, focusing on Love-wave acoustic devices. The final subchapter is dedicated to diamond, exploring its properties, synthesis, and application in biosensing technology. In this chapter, she cites 142 references, which help to support her investigations.

The second chapter announces and establishes the objectives of the thesis. This very short chapter (1 page) could have been combined with the first chapter or even inserted in the motivation part.

Chapter 3 outlines the primary methods employed in this thesis. It details the models used for FEM simulations in COMSOL Multiphysics software, the fabrication and characterization of SAW devices, and the deposition and characterization of diamond layers.

Chapter 4, which constitutes the heart of the experimental work of this thesis, is in turn structured into 8 subchapters each dedicated to a different topic.

- Subchapter 1 describes FEM simulations of LW-SAW device properties after diamond coating.
- Subchapter 2 provides experimental details on LW-SAW devices with continuous and discrete diamond coatings.
- Subchapter 3 offers FEM simulations focused on enhancing the sensitivity of LW-SAW devices using diamond phononic metamaterials.
- Subchapter 4 is shorter, presenting FEM simulations on the use of diamond and silicon carbide layers as passivation layers for LW-SAW sensing technology.
- Subchapter 5 presents experimental results on the behavior of diamond-coated LW-SAW sensors fabricated with various piezoelectric substrates and guiding layer materials.
- Subchapter 6 details the fabrication of our bioreceptor, bacteriophage tail fibers.
- Subchapter 7 focuses on the functionalization of the diamond surface through the attachment of the bacteriophage tail fibers produced in the previous chapter.
- The final subchapter, 8, is devoted to the fabrication of boron-doped diamond-coated QCM sensors for biosensing applications.

A general conclusion comes to summarize the main results obtained in this work and the important achievements but also honestly highlights the things that didn't work. New perspectives for improving the performance of the biosensor are advanced by proposing new strategies that consider what did not work in the doctoral project.

In conclusion, I find that the thesis is well written, and it should be even understandable to reader not familiar with the field. Both the theoretical and experimental parts are extensively described. Even if the use of diamond did not allow the expected performance improvements, the obtained results are very interesting and some of them were already published as paper in international journals or presented in international conferences.

All these considerations allow me to recommend that, Mrs. **Lucie DUBOVSKÁ** defends her thesis in order to obtain the degree of *Doctor of Philosophy. of Czech Technical University in Prague*

Nancy, June 21, 2024

Prof. Omar ELMAZRIA