

Reviewer Report on PhD Thesis of Marie Krečmarová

“Design and realization of the principles of label free detection of DNA molecules using NV centre quantum electron transitions in diamond nanosensor”

The most important part of the PhD thesis of Marie Krečmarová is the fabrication of diamond-based biosensor with electrochemical and NV centre optical readout. The related experiments and their results are described in sections 4.6–4.10. These experiments required some preliminary investigations of the diamond growth and B, N doping (sections 4.1-4.3) as well as the research of the electrochemical properties and photoluminescence in dependence on the diamond doping or film thickness (sections 4.1.4, 4.2.2, 4.4 and 4.5).

The layout of the thesis is not well conceived because the chapter 3. Materials and Methods contains a lot of text that should rather appear in the theoretical introduction of the thesis and the chapter 4. Results and Discussions, on the other hand, contains a lot of experimental details as obvious e.g. from the sections 4.2.1 or 4.4.1 named Experimental details. It leads to unclear relations between the experiments and their results presented in different sections. It also requires references to other parts of the text, i. e. jumping between the sections. As the result the particular conclusions are not bringing a good summary of the work.

The conclusions seem to be a weak part of the thesis because the author decided to write them after each particular section and repeat all the particular conclusions at the end of the thesis. It hindered final answers to the questions that come into reader's mind when going through various types of diamond films, preparation in different plasma reactors and analyses of the structural or functional properties.

The structure of the thesis makes also difficult to find details of some characterization procedures, for example the diamond quality factor calculated from Raman peaks. It is only briefly mentioned in chapter 3., the relation used for its calculation “as a ratio of sp^3 and sp^2 phase” is given later in the section 4.1.4.1 Morphology Study (of NCD from resonant cavity mw plasma) and the procedure how to calculate sp^3 and sp^2 phase from Raman peaks is described even later in the section 4.2.1 Experimental Details (of NCD from linear antenna mw plasma). Anyway, it is not quite clearly written whether sp^2 phase is taken as the sum of Lorentz-shape fitted peaks of the both, D and G bands.

The thesis is written in a relatively good English but several grammar mistakes can be found (“caused due to”, “it's surface”), sometimes repeated through the whole text (e.g. missing nominative). There are also some other mistakes. The numbers on the y -axis of figures 85 and 86 are missing and, therefore, the reader is not able to check the relative increase of the PL intensity described in the text. The reference to the table 1 on page 86 is probably rather the reference to the table 2. The citation numbers in section 2.5 do not seem to correspond to the list of citations. The reference to figure 31 is missing in the text.

The results of the diamond growth were published in two journal papers. The paper representing the main part of the thesis was under preparation in the time the PhD thesis was submitted. It is a pity that one of the chapters in the thesis does not have the form of the paper going to be submitted. According to the text on page 125, it seems that only a little part of the results will be included in the paper under preparation but the proposed title of the manuscript “Diamond electrochemical sensor based on NV centre charge state control” promises to include much more. Therefore, it would be interesting to find out during the PhD defense what is the progress in the manuscript preparation, what results are included and if it has been already submitted to the journal (or even accepted to the publication).

In spite of few unclear points and the remarks on the text layout I found the submitted PhD thesis interesting and containing valuable results leading to the successful fulfillment of the goal of the PhD thesis. Therefore, I propose to accept the submitted thesis as the PhD thesis of the candidate.



Brno, April 3th 2018

Assoc. Prof. Lenka Zajíčková

Questions for the PhD defense:

- Can you comment on the colors of diamond gems type Ia (colorless) and IIa (pink) in figure 30?
- Please, discuss the reasons for the results on the photoluminescence when comparing N-doped NCD from resonant cavity mw plasma (the best result obtained for the lowest percentage of N₂, 0.07% in the gas feed) and N-doped NCD from large linear antenna mw plasma (some photoluminescence observable only for the highest N₂ content of 7%). Can you also comment on differences in the percentage of nitrogen in the films? What other effects and perhaps properties of plasma can lead to so different results?
- Please, discuss the reasons leading to the usage of Seki Technotron AX5010 cavity mw plasma (at IoP ASCR) and Astex AX6500 plasma (at IMO-IMOMEČ) for the growth of different diamond films used in the final design on the biosensor. What are the important reactor and plasma parameters that were decisive for your choice?