



# Review Report on PhD Thesis

Faculty: **Central European Institute of Technology  
Brno University of Technology in Brno**

Academic year: **2019/2020**

Student: **Ing. Michal Horák**

Doctoral study program: **Advanced Materials and Nanosciences**

Field of study: **Advanced nanotechnologies and microtechnologies**

Supervisor: **prof. RNDr. Tomáš Šíkola, CSc.**

Reviewer: **Assoc. prof. Timur Shegai**

PhD thesis title: **Electron microscopy and spectroscopy in plasmonics**

## Topicality of doctoral thesis:

The project is devoted to electron microscopy and electron energy loss spectroscopy (EELS) and cathodoluminescence, as well as to focused ion beam (FIB) studies of various plasmonic nanostructures.

The thesis is divided in four parts devoted to (i) comparative e-beam and FIB plasmonics, (ii) Babinet's principle, (iii) local enhancement and (iv) silver amalgam as a new plasmonic material.

## Meeting the goals set:

In my opinion, the goals of the project are clearly met. They are rather diverse but at the same time complementary. I am overall impressed by the candidate's level.

### **Problem solving and dissertation results:**

There are many nice results in this dissertation. It ranges from fabrication comparison, experimental verification of Babinet's principle in real plasmonic structures, comparison between localized electric and magnetic field enhancing nanoantennas and finally the silver amalgam. Especially the last one, in my opinion is the valuable and novel contribution to the field of plasmonics.

### **Importance for practice or development of the discipline:**

Comparison between EBL and FIB samples are important in practical plasmonics. Silver amalgam is also worth mentioning as a practical result.

Fig.4.6. Overall is a very strong (and impressive) result of this PhD work, as it contains a comprehensive comparison between various antenna's dimensions and designs.

### **Formal adjustment of the thesis and language level:**

(4) The study is duly completed by a state doctoral examination and the defense of a dissertation, which proves the ability and readiness for independent activity in research or development or for independent theoretical and creative artistic activity. The dissertation must include original and published results or results accepted for publication.)

The level of English writing in the thesis is well acceptable for a doctoral dissertation.

### **Questions and comments:**

Fig 2.4 FIB part. Why Ga signal is absent although Ga<sup>+</sup> ions were used for the milling process?

Fig. 3.5. The candidate first says that the Babinet's principle in ideal conductors require the same response of particle and aperture. However, for realistic metals this is not the case. I wonder if the author can explain the differences between the hole and the disk in Fig. 3.5. In particular, why the resonances appear at the designated wavelength?

Fig. 4.3. Why the edge mode and inverted bow-tie are not sketched in terms of charge distribution? I would encourage doing this for the completeness. Same applies for Fig. 4.5.

Fig. 5.3. I am quite impressed by the good agreement between theory and experiment, despite the fact that silver amalgam nanoparticle shapes are rather complex and irregular at first glance. Could the author comment on this? Were there any particles which did not fit this almost perfect trend?

### **Conclusion:**

In my opinion, the reviewed thesis fulfill all requirements posed on theses aimed for obtaining PhD degree.  
This thesis is ready to be defended orally, in front of respective committee.

In Göteborg....., date..... 15-12-2019

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Assoc. prof. Timur Shegai