

## Review of theses by Jaroslava Lavková

**Title:** *Electron Microscopy and Spectroscopy Study of Nanostructured Thin Film Catalysts for Micro-fuel Cell Application*

**Universities:** *Universite de Bourgogne, UFR Sciences et Technique Mirande, Laboratoire Interdisciplinaire Carnot de Bourgogne, Ecole doctorale Carnot-Pasteur; Charles University in Prague, Department of Surface and Plasma Science, Faculty of Mathematics and Physics.*

**Supervisors:** Valerie Potin  
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Theme of the evaluated work, synthesis and characterization of catalysts for micro fuel cell applications, is significant and scientifically extremely interesting and fits into the current world trends in material research focused on energy and environmental issues. Dissertation topic is a part of a long-term research program, which is carried out on both educational institutions on an internationally comparable high level guaranteeing an appropriate scientific level of the evaluated dissertation.

Dissertation itself is handled carefully and systematically. Already in the introductory part, the author demonstrates a good understanding of her own dissertation solved problems and is able to put it precisely into wider context. Reported literature used in the dissertation includes significant and respected sources in this interdisciplinary field. The author demonstrates a good understanding of both material sites solved problems as well as issues related chemicals. Even after the formal work is handled well, including literature citations, clarity of images, etc.

Aim of the study is defined clearly and understandably. The methodology used in experiments and synthetic procedures are well described and allow the reader well orientate within the results. Results of the dissertation is in my opinion both content and scope comparable to most similar dissertation, which I had the opportunity to assess and conforms to the requirements imposed on the doctoral thesis of this type. It is written clearly, is clearly articulated and discussion of results is adequate. Depth discussion of the results shows that the author not only understands the issues, but also has a good overall knowledge from both the electron microscopy, as well as a high level of general knowledge concerning solid materials.

The first and the second chapters of the thesis present the state of the art for PEM fuel cells, their main advantages and limitations. A description of the main catalysts and their carriers is given. The magnetron sputtering method used for the preparation of thin films is also discussed. These chapters also deal with the characterization methods used and the technical details of the operating conditions. In addition to the sample preparation conditions the chapters are mainly focused on electron microscopy, scanning and transmission, and spectroscopic techniques like X-ray energy dispersive spectroscopy, EELS and X-ray photoelectron spectroscopy. The statements are in accordance with current views on the application of electron microscopy and spectroscopies in investigation of various

nanostructured materials, in the presented thesis to novel metal-oxide anode catalyst for fuel cell application, namely, the Pt-CEOX system.

The third chapter is devoted to discussion of the obtained results. Both undoped and doped samples with a small amount of platinum have been developed and characterized for an application as catalysts for fuel cells. It was demonstrated in this chapter that by suitable combination of deposition conditions, it is possible to tune catalyst morphology and to obtain very porous structure with high surface area. Obtaining these materials with tailored properties implies control of their growth conditions. According to the presented micrographs, the samples seem to be rather uniform in morphology as well as in the chemical composition. I have no negative comments to these parts of the thesis. The positive is the fact that author uses several methods of characterization based on different physical principles, results thereby gain credibility. As a whole, according to my opinion, author contributed significantly to understanding the processes occurring during deposition of active layers on carbonaceous substrates suitable for application as electrode materials for fuel cells.

Questions and comments:

1. Were any of your materials tested in real fuel cells? With what results?
2. Author declares in thesis that „two main processes were occurring simultaneously during the magnetron sputtering: deposition of cerium oxide and oxygen plasma etching of carbon“. Can these processes be controlled independently by setting the conditions of sputtering?

As a whole, I appreciate the work as very nice and helpful. It is rather extensive, especially in terms of data. I have no negative comments to the text. I appreciate positively the publishing activity of the Ms. Lavkova, 9 publications in the WOS database are in my opinion rather above average for PhD. students. In conclusion, according to my opinion, Jaroslava Lavková fulfilled all the necessary requirements for granting a PhD. degree according to the applicable laws. Therefore I suggest that the work has been accepted for the defense.

Prague (Czech Republic) 28. 04. 2016.

Ing. Jan Šubrt, PhD.