FACULTY OF APPLIED SCIENCES
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Habilitation thesis reviewer's report

Applicant: RNDr. Pavel Solař, Ph.D.

Habilitation thesis: Novel routes for nanoparticle synthesis using gas aggregation sources and the study of nanoparticle interaction with substrates

The habilitation thesis focuses on the synthesis of nanoparticles (NPs) using a magnetron-based gas aggregation source. It comprises seven scientific publications, six of which were published in high-quality international journals, while one was published within the proceedings of the International Conference on Nanomaterials. The applicant is the first author and at the same time corresponding author of six publications. The compilation includes well-written text providing the background to the research and discussing its most significant findings.

The thesis is organized into three parts, each dedicated to a distinct aspect of the research. The first part (publications no. 1–4) concentrates on the synthesis of various composite NPs. This segment is particularly valuable as it introduces novel ideas and insights into the preparation of core-shell NPs, a task known for its complexity.

The second part (publications no. 5 and 6) delves into the investigation of NPs velocity outside the gas aggregation source. This section offers valuable new insights into the velocity of NPs outside the gas aggregation source. Such information is crucial not only for experimental work but also for theoretical studies concerning NPs growth and transport.

The final part (publication no. 7) is dedicated to studying the reflection of NPs from the substrate, contributing to an understanding of substrate-related phenomena observed during the synthesis of lightweight and elastic NPs.

All three topics are highly relevant. The thesis proves that the applicant has mastered using state-of-the-art instruments, original designs of experiments, and complex data analysis to understand the complex phenomena related to the synthesis of the NPs using the gas aggregation source. Here, I would like to highlight the complex experimental setup and the demanding evaluation of the obtained data during the investigation of the speed of NPs outside the gas aggregation source.

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The obtained results are highly original and competitive on the international level and have led to significant advances in the understanding in the field of NPs synthesis. The experimental setups employed, coupled with the comprehensive discussion of results, are of a high standard.

The high compliance percentage with the Turnitin system is attributed to the structure of the applicant's habilitation thesis, comprising a collection of scientific publications accompanied by commentary. The applicant is an author or co-author of all these publications.

Reviewer's questions for the habilitation thesis defense

1. (Publication no. 1) The use of immiscible materials to create core-shell NPs indeed makes sense from a thermodynamic perspective. However, it's challenging to envision how the core-shell NPs are formed considering the relatively low energy of the impacting atoms. Could you provide further insight into the kinetics of forming the studied core-shell NPs?
2. (Publication no. 1) When metal NPs are exposed to ambient air, an oxide layer is typically formed quickly at the surface. How did you passivate the Cu-W nanoparticles investigated using TEM?
3. (Publication no. 2) Typically, the flux of sputtered atoms correlates with the discharge power, as the number of impacting ions is proportional to the discharge current, and their sputtering yield relates to the target voltage. Was there any specific reason to operate the discharge using a constant current mode instead of a constant power mode?
4. (Publication no. 4) In this study, high-purity (99.9999%) Ar and O_2 gases were used. In contrast, lower-purity gases were utilized in the other works. What was the reason for using the high-purity gasses? What is your experience with utilizing gases of various purity for the synthesis of NPs?

Conclusion

The thesis meets the standard requirements for a habilitation thesis. I highly recommend the thesis entitled "Novel Routes for Nanoparticle Synthesis Using Gas Aggregation Sources and the Study of Nanoparticle Interaction with Substrates" by Pavel Solař for further consideration in the habilitation procedure.

doc. Ing. Jiří Čapek, Ph.D.

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