UNIVERSITY of VIRGINIA
ENGINEERING
DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Habilitation Committee

Dr. Viktor Johánek

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Honored Committee,

Thank you for inviting me to participate in the assessment for Dr. Viktor Johánek's submission. Dr. Johánek's habilitation thesis is of the highest quality and I enthusiastically recommend its acceptance. His work is evidence of his qualifications, and he is without any doubt qualified to join the academic faculty at Charles University and serve the scientific community and students for many years to come.

Before I discuss his work in more detail, let me briefly introduce myself. I am a Professor in the Department of Materials Science and Engineering at the University of Virginia with a research group specializing on thin films, nanostructures, and corrosion. Work in my research group is positioned at the intersection between Materials Science, Chemistry, and Physics. My research can broadly be characterized as Materials Science at Surfaces and we study a wide range of surface reactions of relevance to technical advances in nanomaterials and surface chemistry. This includes the formation of magnetic nanowires, synthesis of 2D silicene, and manipulation of graphene. A few years ago we extended our portfolio to include oxidation, and aqueous corrosion, and collaborate extensively in the study of alloy surface reactions. We focus specifically on the initial oxidation steps where the alloy transforms to an oxide via a complex reaction steps – made even more challenging by the competition between several elements on alloy surfaces. We are an experimental group and integrate simulations, data analytics, and machine learning in our work.

My expertise intersects with Dr. Johánek's work, albeit his work is more firmly grounded in the study of catalytic reactions, using many aspects of materials design to understand catalysts, supports, and the associated chemistry.

Comments on plagiarism check by Turnitin: The habilitation thesis submitted by Viktor Johánek included a high similarity index with a "student paper" submitted to Charles University, which is a local repository to the best of my understanding. All other sources have a similarity index of 1% or less which confirms that Viktor Johánek's publications are highly original and emerged from his own work over the course of nearly two decades. As such I do not find any issues with plagiarism in his work.

Dr. Johánek begins his Habilitation Thesis with an excellent introduction, which gives a comprehensive insight in the motivation and scientific underpinning of this work. It clearly relates chemistry and materials science of the catalyst and support, and illustrates Dr. Johánek's ability to capture complex scientific problems, and distill their essence to the benefit of the reader. Dr. Johánek provides in the appendix copies of 21 publications and has reached an h-index of 29 with cumulatively 3135 citations (google scholar October 10th 2022). The publications illustrate his skill and inventiveness as an experimentalist who studies complex questions which address fundamental challenges in nanoparticle supported catalysis. The breadth of his work is evident and includes microkinetic studies, size dependent bistabilities in nanoparticles, growth mechanisms of graphene and nanoparticle-support interactions. In the following I will discuss three specific publication which are evidence for the excellent quality of his work.

Appendix 6 – Fluctuations and Bistabilities on Catalyst Nanoparticles: Size-dependent changes in reactivity occur in most nanoparticles and catalysts and are often attributed to changes in electronic structure or adsorption site geometries. This publication took a novel approach and used nanoparticle deposition methods which allowed for fabrication of a wide range of particle sizes as the basis for reaction experiments with O_2, and CO. The competitive kinetics leads to a kinetic phase transition. The particle size influences the fluctuations, and leads to their disappearance for small particles. Associated microkinetic modeling helped to unravel the mechanisms of bi-stable behavior as a function of reaction conditions, particle size, and defect concentration. The complexity of these interlinked processes is significant and this work convincingly argues all relevant mechanistic details. The publication in Science with Dr. Johánek as first author is confirmation of the high quality of this research, and it is still cited and relevant.

Appendix 4 – Counting Electrons on Supported Nanoparticles: Dr. Johánek was part of a team for this publication in Nature Materials from 2016, a high impact factor journal. His contribution was the STM and XPS study of Pt nanoparticles which reside on an insulating support – the central theme of the manuscript. The charge transfer from particle to support is limited and strongly particle size dependent. This reflects a realistic scenario in catalysis, where particles in the nanometer to hundred nanometer size range are immobilized on insulating supports such as ceria which was also used here. The quantitative measures of the electron transfer shed light on a critical contribution to the reaction kinetics on nanocatalysts. Especially the correlation between particle size and oxygen vacancy defects in the support is important and summarizes succinctly the competing pathways for electron transport. This work is a seminal contribution to our understanding of the catalyst-support interaction.

Appendix 13 - Methanol to hydrogen conversion on cobalt-ceria catalysts prepared by magnetron sputtering: was published in 2021 in "International Journal of Hydrogen Energy" and Dr. Johánek is first author in this recent contribution to the development of catalysts for alternative energy resources. The catalyst materials were prepared with sputter deposition methods, which allowed for unique control of materials. The bi-functionality of different Ce and Co redox pairs could be probed due to the tight control of materials synthesis in combination with reaction studies. This work demonstrates Dr. Johánek's approach to combine reactivity studies with tight control of materials parameters to great effect

Dr. Johánek showcases with this body of work his significant contributions to our understanding of catalytic processes based on the use of nanoparticles on oxide supports. He has studied a wide range of reactions often combined with targeted materials synthesis – a particularly fruitful and informative approach. He has published as first and lead author, and frequently collaborates with colleagues (e.g. Prof. J. Libuda at Friedrich-Alexander-Universität Erlangen-Nürnberg).

Dr. Johánek's contributions to the science of catalysis are significant, and his work is of the highest quality.

I remain with best regards, and am available for any questions which might arise during the proceedings.

(Petra Reinke)