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Supervisor report on the doctoral thesis “Research and development of platinum-based cathode catalysts for proton exchange membrane fuel cells” by Mgr. Xianxian Xie.

The doctoral thesis of Mgr. Xianxian Xie addresses proton exchange membrane fuel cells (PEMFCs), a pivotal component of the Green Deal initiative aimed at promoting sustainable energy solutions. Specifically, the research focuses on optimizing the structure and composition of cathode catalysts to enhance their cost-efficiency and stability, which currently represent one of the main obstacles to the widespread market entry of such fuel cells.

The thesis is structured into three chapters. In the first chapter, the composition-activity-stability relationship of bimetallic Pt–Au alloys with various compositions prepared by magnetron co-sputtering from two individual targets was systematically investigated. It was observed that the Pt–Au catalyst with 10 at.% of Au demonstrated the most optimal alloying, retaining the activity of Pt while effectively suppressing Pt dissolution. In the second chapter, the composition-activity-stability relationship of ternary PtNi–Au alloys with different compositions prepared by magnetron co-sputtering from three individual targets was explored. Among the tested catalysts, the PtNi–Au alloy with 15 at.% of gold exhibited the highest stability while showing even higher activity than monometallic Pt. The third chapter explores a highly porous Pt–C catalyst prepared by electrochemical dealloying of ternary Pt–C–CeO_x compound deposited by magnetron co-sputtering from three individual targets. Pt–C catalysts exhibited significantly increased electrochemically active surface area (ECSA), enhanced ORR activity, and improved stability compared to monometallic Pt. The research is supported by a broad portfolio of diverse characterization techniques, which enabled to draw robust and well-substantiated conclusions. The obtained findings provide valuable insights for the development of efficient and durable cathode catalysts for PEMFCs.

During her doctoral study, Mgr. Xianxian Xie became experienced in operating multiple characterization techniques at domestic institution. Furthermore, she participated in measurements abroad utilizing advanced equipment, such as SRPES at Elettra synchrotron in Trieste (Italy) and SFC-ICP-MS at HI-ERN in Erlangen (Germany). Her experimental work demonstrates a high level of quality and systematic approach. Consequently, the results

described in the first and third chapters were published in reputable journals. Currently, the manuscript is being prepared based on the results of the second chapter.

Overall, the doctoral thesis is written clearly, with a high scientific, technical, and graphical level. I am confident that the thesis fulfills all the criteria placed on a doctoral thesis. Therefore, I recommend awarding Mgr. Xianxian Xie the title of Doctor of Philosophy.

Prague, 05.04.2024

Doc. Mgr. Ivan Khalakhan Ph.D.