University
of Pardubice
Faculty
of Chemical Technology

Recommendation of the MSc. Mehran Sajad's supervisor

Thesis title: "Production of light olefins via (oxidative) dehydrogenation of light alkanes over nontraditional heterogeneous catalysts"

Dissertation by MSc. Mehran Sajad is focused on studying the conversion of light alkanes to the corresponding alkenes by oxidative or non-oxidative dehydrogenation catalyzed by non-traditional catalysts. The dissertation is presented by the MSc. Sajad for the defense in the seventh year of study, so it contains the results of his work in the period 2017-2023. MSc. Sajad first studied full-time, but from the fall of 2021, i.e. from the fifth year of study, he switched to a combined form of study and started working full-time as a researcher on the GAČR project.

Results of the MSc. Sajad's dissertation have been published in four peer-reviewed journal papers and one manuscript is currently being completed. The dissertation is presented as an annotated collection of these publications and the manuscript. From a material point of view, the work can be divided into three topics, which are closely related and interconnected by the studied catalytic process of alkane to alkene conversion. The first part of the dissertation is devoted to the study of a complicated catalytic system of eutectic mixtures of chlorides of alkali metals and alkaline earth metals with La-zeolite of the FAU type. This catalytic system appeared at the same time that the PhD student began his studies. The excellent catalytic properties were published, but the stability analysis of this system was lacking. Therefore, the doctoral student focused on a detailed study of the stability of the catalytic performance of this catalytic system and, after a series of investigations, came to the conclusion that this system is subject to deactivation by the loss of chlorine and the conversion of chlorides to oxides, which show significantly lower activities. Additionally, chlorine tended to be incorporated into the resulting products in the form of chlorinated hydrocarbons, which are undesirable and toxic. Since stabilization would require oxychlorination, a process that is not desirable for practical applications, the PhD student focused his attention in the next stage of his study on two other very novel catalytic systems, (i) palladium nanoparticles encapsulated in microporous zeolitic matrices and (ii) to hexagonal boron nitride (h-BN). In cooperation with the research team of prof. Čejka from Charles University, he investigated the catalytic properties of palladium encapsulated in the so-called ADOR zeolites of the IPC-2 and IPC-4 types and in the MFI zeolite. In his dissertation, the doctoral student focused on the catalytic activity and stability of these ultra-small palladium clusters with dimensions around 1.5-2 nm in the direct

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dehydrogenation of propane. He confirmed the stabilizing effect of encapsulation in microporous silicate supports together with good accessibility of nanoclusters for propane, which led to the observation of very good activities in the direct dehydrogenation of propane to propene with high selectivity. In the last part of the dissertation, the doctoral student dealt with the physicochemical changes taking place on the surface of the h-BN catalyst during the oxidative dehydrogenation of propane and the effect of these changes on the catalytic activity. At the same time, he studied the design of the reactor and its influence on the catalytic performance of the entire system. He unequivocally demonstrated that the contribution of the surface reaction and the gas phase reaction in the radical mechanism of oxidative dehydrogenation on this catalytic system can be tuned by the layout of the catalytic bed and the geometry of the reactor.

The dissertation produced a number of very interesting and original results published in the presented four publications and the manuscript in preparation. I believe that part of the experimental data obtained by the doctoral student will find its application in other manuscripts, the preparation of which is planned for the coming weeks and months. From the first year, the doctoral student also participated very actively in presenting the results of his work at conferences. During the past six years of study, he presented 17 lectures and 11 posters at both national and international conferences.

The doctoral student's approach to experimental work and analysis of results was systematic. During his studies, he mainly focused on conducting catalytic tests, however, he also gained experience with a number of characterization techniques, from the study of texture using adsorption, temperature-programmed techniques and spectroscopic characterizations such as FT-IR. In addition, he was actively involved in the life of our research group, in university activities for the integration of foreign students and researchers into the life of the academic community at the university, and in recent years also in mentoring activities organized by the University of Pardubice.

In my opinion, the doctoral student met all the requirements for a doctoral student, demonstrated the ability to independently work scientifically and formulate conclusions based on the results. For these reasons, I recommend accepting the dissertation of MSc. Mehran Sajad for the defense.

In Pardubice on 3rd November 2023,

prof. Ing. Roman Bulánek, Ph.D.
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