ATTITUDE OF REVIEWER

by prof. Dr. Anton Naydenov
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for the scientific contributions of the works on Assistant Professor Dr. Ivan Bogoev Ivanov, Institute of Catalysis, Bulgarian Academy of Sciences, presented for participation in a competition for the academic position "Associate Professor" in professional direction 4.2. Chemical sciences, scientific specialty "Kinetics and catalysis", announced in the State Gazette: issue 55/ 27. 06. 2023.

In the contest, the candidate participated with seventeen publications with an impact factor (7 of them in Q1, 5 in Q2 and 5 in Q4). In the habilitation author reference, 5 publications are presented (4 of them are in Q1, of which 1 is in Q1, leading the ranking list and 1 in Q4, where the candidate is listed as the first author). Of the candidate's total of 37 publications, 36 are in impact factor journals, with 13 of them in Q1. 12 publications are presented in the author reference outside of the habilitation work under indicator G7 (3 of them are in Q1, 5 in Q2 and 4 in Q4). The observed citations on the publications participating in the contest are 242. The scientific publications presented by the candidate are mainly related to the development and research of nano-sized ceria-oxide catalysts for the low-temperature conversion of CO with water vapor in order to obtain hydrogen. Results of our research on the influence of the preparation method and the nature of the dopants on the catalytic activity in the CVD of gold-coated catalysts on transition-metal-doped cerium oxide doped with different metal oxides (Me = Fe, Mn, Sn) by two different methods are presented: coprecipitation (CP) and mechanochemical activation (MA). It has been observed that the method of preparation and the nature of the applied additive affect the catalytic activity in WGS. The differences in the catalytic activity in WGS between the samples obtained by MA and CP were significant and the catalysts synthesized by mechanochemical activation were more active than the co-precipitated ones. The characterization results reveal that the CP method leads to bulk modification of the catalysts by the dopant metal, while the MA method causes only surface modification. A high and stable activity of the cerium oxide catalysts doped with Fe and Mn was found. Cerium oxide doping improves oxygen mobility, i.e. a higher oxygen capacity was observed compared to the gold catalyst on undoped ceria, and this effect was stronger for the MA samples. The presence of gold particles with a smaller size and a high concentration of Ce^{3+} ions has been recorded by XPS in the highly active catalysts containing Fe or Mn, which is consistent with the previously proposed model for the active sites in WGS. It is shown that iron-doped cerium oxide samples, synthesized by mechanochemical mixing and impregnation methods and subsequently modified with gold, are active in the reaction of WGSR and selective oxidation of CO in the presence of hydrogen. The gold-coated samples on supports prepared by impregnation showed WGS activity lower than that of the gold on undoped ceria. Significantly better performance in WGS was observed for supported gold catalysts synthesized by mechanochemical mixing. The observed differences in the catalytic behavior are explained by the crucial role of the gold dispersion and the properties of the multicomponent supports depending on the preparation method. The high activity and stability in WGS of Au5FeCeMM and the resistance to

deactivation of Au10FeCeIM in SelOx indicate that these gold-supported catalysts are promising for practical applications. The production of pure hydrogen by low-temperature WGS was investigated, we used a cerium oxide carrier synthesized by a new and cheap extractive-pyrolytic method and where platinum was deposited instead of nanosized gold. By varying the Pt content, it was found that the maximum catalytic activity was achieved with a sample containing 1.2 wt.% Pt, reaching up to 98% CO conversion rate at a temperature of 250°C. The effects of the preparation method and the amount of yttria-doped cerium oxide deposited on alumina in the WGS reaction were investigated. Catalysts based on nanosized gold have shown high activity in the WGS reaction at relatively low temperatures. Researches are aimed at the preparation of suitable and economically advantageous and stable carriers with a complex composition by various synthesis procedures in order to increase their activity in the WGS reaction. Mechanochemical mixing has been confirmed as a more suitable method than impregnation, as it favors the presence of a higher surface concentration of the gold nanoparticles and Ce3+, considered as active sites for CO activation and water dissociation, respectively, during the WGS reaction. Catalytic tests have shown that a larger amount of CeO2 is needed to achieve acceptable carbon monoxide conversions, and the effect of the Y-dopant also depends on the synthesis method used.

It is shown that the combination of gold nanoparticles and aluminum oxide supported on Y-doped cerium dioxide is a promising approach for the development of new catalytic samples with high efficiency in the production of pure hydrogen. In the studies on the influence of the preparation method for copper-based catalysts in the WGS reaction, it was established that the addition of yttrium affected the catalytic activity of Cu in a different way depending on the preparation method of the mixed cerium-alumina oxide supports. A positive effect on the activity in WGS is observed in the case of mechano-chemical mixing.

Conclusion

The research of Assistant Professor Dr. Ivan Bogoev Ivanov fully meet the topic of the announced competition for the award of the academic position "Associate Professor". The publishing activity, the quotations on the published results, the participation in projects of Assistant Professor Dr. Ivan Bogoev Ivanov fully meet all the requirements of the Law on the Development of Academic Staff and the Regulations on the terms and conditions for obtaining scientific degrees and holding academic positions at the Institute of Catalysis, Bulgarian Academy of Sciences. Therefore, I strongly recommend to the members of the esteemed Scientific Jury and the esteemed Scientific Council of the to sentence Assistant Professor Dr. Ivan Bogoev Ivanov the academic position "Associate Professor" in the field of 4.2. Chemical sciences (Kinetics and catalysis).

Sofia, 01.11.2023

Signiture: Подписът е заличен в Съответствие със ЗЗЛД

Prof Dr. Antoń Naydenov