



## STANDPOINT

Submitted by Associate Professor Maya Georgieva Shopska, PhD, from Institute of Catalysis at Bulgarian Academy of Sciences on the basis of document set presented for participation in a Competition for occupying an Academic position "Associate Professor" in professional field 4.2. "Chemical Sciences" (Specialty "Chemical Kinetics and Catalysis") published in State Gazette, issue 55 dated 27. 06. 2023

Assistant Professor Ivan Bogoev Ivanov, PhD, has applied for the Competition announced by IC-BAS for occupying the AP "Associate Professor" for needs of "New Heterogeneous Catalysts for Clean Energy and Protection of the Environment" (NHCCEPE) laboratory.

### Data about the candidate

Mr. I. Ivanov graduated University Prof. Dr. Asen Zlatarov-Burgas in 1994 with a chemical engineer qualification (Master of Science). Since 2003 till now he works in the IC-BAS where in period of 2003-2008 is a full-time PhD Student in the NHCCEPE laboratory. He acquired PhD Degree in Specialty "Chemical Kinetics and Catalysis" after defense of a thesis entitled "Gold catalysts supported on  $\text{CeO}_2.\text{Al}_2\text{O}_3$  for water gas-shift reaction". Since 2009 till now he occupies a position "Assistant Professor". In period of 2008-2016 I. Ivanov specializes in different foreign scientific institutions (Norway, Spain, Czech Republic, and Italy).

### Estimation of the research and applied research activities of the candidate

The information presented about fulfilment of conditions required from Law for the Development of the Academic Staff in the Republic of Bulgaria (LDASRB) shows that Mr. I. Ivanov covers all criteria. The habilitation report with which the candidate participates in the Competition includes 5 papers as 4 of them are published in journals indexed with Q1 quartile and one of them is topping the rankings. One paper is published in journal indexed with Q4 quartile. Journal impact factors are between 2.3 and 7.4. Dr. I. Ivanov is first author in one article and second author in two of them. 69 are the noticed citation on these materials. This group of publications and their evaluation according the LDASRB correspond to 112 points as the minimal requirement needed to cover criterion B4 is 100 points. Articles included in the non-habilitation report for the participation in the Competition and corresponding to criterion G7 are 12. Three of them are published in Q1 journals, 5 numbers are in Q2 journals and 4 papers are in scientific periodicals indexed by Q4 quartile. Journal impact factors are between 0.2 and 4.7. The applicant is second author in one of the articles and third one in most of the others. The citations noticed for this group of publications are 143. According the LDASRB thus described scientific materials correspond to 223 points as the required minimum is 220 points the criterion G7 to be met.

All publications of the candidate for the entire period of his research activity are 40 and their citations number 1006. The international prestige of the journals and the high quotation of the works show actuality of the scientific direction and research topic he works in as well the importance of the obtained results. Assist. Prof. I. Ivanov has  $h\text{-index}=16$ , which is higher than the required one for the AP "Associate Professor". The results obtained with his participation are presented at 10 national and 13 international meetings in form of 4 oral and 27 poster presentations.

### Scientific contributions of the candidate

The materials included in the habilitation report submitted for consideration by Mr. I. Ivanov deal with a question about synthesis of  $\text{H}_2$  with application in fuel cells through the Water Gas-Shift Reaction (WGSR). Development of nano-sized ceria catalysts for low-temperature WGSR

has scrutinized there in. The papers concern Au-, Pt- and Cu-containing catalysts. The influence of the synthesis method and nature and amount of the dopant (Mn, Fe, Sn, Y) on the catalytic activity in the test reaction is examined. The used synthesis methods are coprecipitation, mechanical treatment, and impregnation. It has been found that mechanically treated samples show higher activity due to intrinsic to them higher dispersion. Also an interaction with the dopant is realized in the surface layer only ensuring higher concentration of sites active in CO activation and water dissociation, namely Au nano particles and  $Ce^{3+}$  ions. The other methods used to obtain catalyst materials lead mainly to volume modification of ceria with formation of inactive/less active phases. In case of Fe dopant has been registered formation of a solid solution. In case of Y dopant a surface phase characterized by high amount of oxygen vacancies connected to unreducible  $Y^{3+}$  ions has been found. This determines an interrupting in the  $Cu-O_{vacancy}-Ce$  interaction, which resulted in lower activity. Among the modified catalysts obtained by the mechanical treatment several samples have been distinguished as very active: Au<sub>5</sub>FeCe-MM, AuY<sub>30</sub>CeAl-MM, CuYCeAl-MM.

The research articles from the non-habilitation work of the applicant presented in the Competition documents are divided in two groups. First group includes investigations on Au-containing samples for PROX and WGS. The influence of the synthesis method, dopant nature (Fe, Mn, Co, Zn, Pr, Y) and H<sub>2</sub>O and CO<sub>2</sub> addition on PROX has been studied. It has been established that modified by Fe(Mn) catalysts are more active. It is supposed that Au/FeO<sub>x</sub>(MnO<sub>x</sub>) particles contribute to high selectivity and activity in the test reaction. The addition of H<sub>2</sub>O and CO<sub>2</sub> has resulted in a significant suppression of the activity. A Fe-containing sample has shown activity loss in WGS long-lasting stability examination but the oxidative treatment restored the initial conversion. This finding testifies the necessity of the new experimental conditions selection. Y-containing catalysts are characterized by high activity in the interval of 180-220C. The studies of gold catalysts with Zn-containing supports have revealed not only high WGS activity but also resistance to start/stop procedures characteristic about the H<sub>2</sub> powered mobile devices. Second group of studies concerns Cu-Mn catalysts for the WGS. Cu<sub>0.8</sub>Mn<sub>0.2</sub>Fe<sub>2</sub>O<sub>4</sub> sample has shown the highest activity amongst the manganese-ferrite systems. Other research deals with Au addition effect on the properties of Cu-Mn ferrites and Cu-Mn mixed oxides supported on Al<sub>2</sub>O<sub>3</sub>. The effect on the first system is opposed to that on the other one. The first case has been explained with an increase of the ferrite crystallite size while in the second case it is supposed that Au stimulates structure destruction to formation of two highly dispersed phases of Au and Cu.

#### Conclusion

The scientific investigations of Assist. Prof. Dr. Ivan Ivanov correspond to the theme of the announced Competition. The documents show total cover of all the criteria envisaged in the LDASRB and Regulations for the conditions and the order for awarding scientific degrees and occupying academic positions in IC-BAS. On this basis, I recommend to the respected members of the Scientific Jury of the Competition and the Scientific Council of the IC-BAS to award the AP "Associate Professor" in scientific field 4.2 "Chemical Sciences" (Specialty "Chemical Kinetics and Catalysis") to Assist. Prof. Dr. Ivan Ivanov.

Sofia  
25.09.2023

Member of the Scientific Jury, Signature:  
/Assoc. Prof. Maya Georgieva Shopska, PhD/

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Съответствие със ЗЗЛД