

SCIENTIFIC APPRAISAL

on the competition for the occupation of the academic position "Professor" at the Institute of Organic Chemistry with the Center of Phytochemistry (IOCCP) at BAS in the field of chemical sciences, code 4.2.

scientific specialty "Organic chemistry" for the needs of the laboratory "Chemistry of Solid Fuels" announced in the Bulgarian State Gazette, issue No. 40/31.05.2022

Prepared by: Prof. Dr. Maya Datchkova Stefanova, IOCCP-BAS, Member of the Scientific Jury appointed by the Order № RD-09-93/11.07.2022

In the competition for the occupation of the academic position "Professor", announced in Bulgarian State Gazette and on the website of IOCCP-BAS, **Associated Professor Dr. Boyko Georgiev Tsyntsarski**, IOCCP-BAS is the **only** applicant.

1. General presentation of the procedure and the applicant

Documents and materials provided by Assoc. Prof. Dr. Tsyntsarski on paper and on the Institute website comply with the requirements for occupying the academic position "Professor". The set is composed by: 1. CV according to the European model; 2. Copies for the acquiring PhD degree from 20.04.2006 and a certificate from BAS for an academic position "Associate professor" from 2013; 3. Abstract of the defended PhD thesis; 4. Extended habilitation reference for his scientific contributions in Bulgarian and English; 5. Total list of scientific publications - 107 items, where 50 are published after his habilitation; 6. List of publications from the Groups B and D according to the requirements of IOCCP - BAS (see Template for the criteria - attached); 7. List of participations in scientific meetings - 12 items; 8. List of citations (without autocitation) - total 1096, from them 817 after habilitation; 9. List of the scientific and scientific-applied projects with his participation as a leader or participant - 8 items;

Assoc. Prof. Dr Tsyntsarski has graduated the National Natural-Mathematical High School "Acad. L. Chakalov", class "Chemistry", after he studied at the Faculty of Chemistry of the Sofia University "St. Kl. Ohridski", doctoral degree he has from the IGIC-BAS under the scientific supervision of the Academician K. Hadjiivanov. Since January 2003, he has an employment contract at IOCCP- BAS, respectively, in the laboratory "Organic reaction on microporous materials" (2003-2006) in the group of Prof. T. Tsoncheva and until now in the laboratory "Chemistry of Solid Fuels" in the group of Prof. Dr. N. Petrov and Prof. Dr. T. Budinova. Since 2018 he is the head of the laboratory.

2. General characteristics of the applicant's activities

In the competition for the "Professor" position, Assoc. Prof. Dr. Tsyntsarski applies with 5 publications from group B, in which he is the first or corresponding author, respectively 2 x Q₁, 2 x Q₂ and 1 x Q₄ and other 12 from the group D, resp. 6 x Q₁ and 6 x Q₂. With this publication activity, the applicant fulfills the requirements of the IOCCP for the position. In the group X are presented 7 publications, named as "others".

In his scientific activities the applicant was concentrated on three main topics. The research is mainly focused on the search for an appropriate application of waste materials from industry

and agriculture for the preparation of "value-added" products, so called "valorization". In this respect are the following publications: - preparation of adsorbents from a by-product of the production of biodiesel from algae (B1) and natural asphaltites (B2); - the possibility of utilizing waste biomass from agriculture and low-rank coal for the synthesis of catalyst carriers applied in methanol decomposition to hydrogen (B3); - synthesis of activated carbon (AC) based on polymer waste products for purification of aqueous solutions from mercury ions. The prepared adsorbent is distinguished by a high adsorption capacity of 196 mg/g (B4); - The adsorption behavior in an aqueous solution towards phenol of differently modified AC prepared by coal tar and its furfural blends and from other low cost coal waste products (B5).

Nowadays the search for alternative energy sources is of utmost importance. Particular attention is paid to hydrogen as an opportunity for future decarbonization of the energy system and transition from a "hydrocarbon" to a "hydrogen" economy. And from here appears the main problem - finding suitable feedstocks and methods for preparation and materials for hydrogen storage. In this respect, the candidate's research is extremely relevant, as it aims at obtaining innovative materials for hydrogen storage. One possibility is magnesium hydrides, another approach is methanol, which is a promising liquid fuel from which hydrogen can be obtained at the necessity moment. For the purpose, it is obligatory to synthesize cheap, working at low temperatures, active and selective catalysts for the methanol decomposition.

An essential part of Assoc. Prof. Dr. Tsyntsarski's research is aimed at obtaining innovative materials for hydrogen storage. The new metal-carbon composites synthesized from nanoporous carbon, carbon foam, graphene, etc. or based on waste products from industry and transport, polymers, oils, waste from the woodworking, canning industry, etc. are cheaper, market-competitive precursors for the synthesis of the new materials. In study **G1**, the adsorption of hydrogen by a composite 95% Mg-5 wt.% AC synthesized on the basis of polyolefin wax, a waste product in the production of polyethylene, was studied. Peach stones (waste from the canning industry) and coal processing by-products, e.g. tar from pyrolysis of low-grade coal, are modified with $Ni_xZn_{1-x}Fe_2O_4$. The resulting carbonaceous materials were found to have potential applicability as cheap and efficient catalysts for hydrogen production (**G2**). An intelligent integrated scheme for the total utilization of biomass for obtaining clean energy including the production of AC-based catalysts for the decomposition of methanol to hydrogen has been developed. Particularly important here is the fact that AC and methanol are received from waste biomass and are a prerequisite for achieving a waste-free process or limiting the volume of the agricultural wastes (**G3**). The study devoted to the cleaning of flue gases from CO_2 by AC obtained from peaches, olives, apricots stones and other agricultural waste was highly appreciated in the specialized literature. The synthesis is carried out by combining pyrolysis and steam activation. The method was developed in the laboratory "Chemistry of Solid Fuels" and further successfully improved in the research of Assoc. Prof. Dr. Tsyntsarski (**G4**). Carbon composites can be successfully used for the production of electrodes (**G5**). The same composites with enhanced thermo-mechanical, tribological properties and relatively low density have potential applications in the medical, military and aviation industries (**G6**). Modifications with $Ni_{0.5}Zn_{0.5}Fe_2O_4$ carbon materials performed better as catalysts for hydrogen production in the methanol decomposition (**G7**). In **G8**, other composites are proposed, i.e. 80 wt.% MgH_2 -15 wt.% Ni-5 wt.% AC synthesized from polyolefin wax (POW), a waste product from the production of low-pressure polyethylene or 90 wt.% MgH_2 -5 wt. %Ni- 5 wt. % POW. The hydrogen sorption characteristics during a cycle of hydrogenation/dehydrogenation of AC from

apricot stones and bean pods were compared (G9). In G10 the possibility for AC regeneration applied in flue gases CO₂ cleaning in a laboratory scale installation was studied.

Investigations on "adsorption from aqueous solutions" and on the possibilities for waste water cleaning from impurities of chemical, pharmaceutical, rubber, paper industries, etc., are widespread in the applicant scientific activity. Organic compounds, i.e. phenol and its derivatives, pesticides, aliphatic and aromatic hydrocarbons, dyes, surfactants, etc., as well as heavy metals (Pb, Hg, As, Cd, Ni, Cr, etc.) were under consideration. The possibilities for increase in the adsorption capacity of AC through appropriate chemical modification were considered. From this cycle of study is the synthesis of nanoporous carbon based on phenol-formaldehyde resin and polyethylene. The resulting adsorbent was characterized by well-developed surface, high porosity and well expressed adsorption capacity towards aromatic compounds (G11, G12).

Assoc. Prof. Dr. Tsyntsarski was responsible and a participant in the work on several national and international scientific projects. Within the framework of the collaboration with other countries, he is the head of long-term fruitful cooperation with Poland and Romania. He was the head of a project with NFSR and participates in projects of the youth colleagues. For the period 2018-2022, he has presented the results of his research at 12 national and international scientific events, at which he took part by 10 oral presentations, two of them plenary. In ten of the reports, he is the first author.

The extended habilitation reference is concisely written and clearly reflects the applicant's scientific contributions. The prospects for future scientific research are also very ambitious, but this is understandable due to the fact that the candidate is on the threshold of his maturity, with already accumulated considerable experience and knowledge.

3. Critical remarks and recommendations

Some small roughness details can be felt in the part describing extended habilitation reference of the applicant; however this does not decrease its high scientific value. Assoc. Prof. Dr. Tsyntsarski missed to note PhD thesis in the reference in the group of indicators A (according to the template).

4. Personal impressions of the applicant

From our long work in the laboratory "Chemistry of Solid Fuels", I have personal impressions of Assoc. Prof. Dr. Tsyntsarski. He is a humble, motivated, hardworking, responsive colleague who is a good leader and works well in a team. For the period from 2018 to today, he was a successful head of the laboratory and several projects and was able to maintain and upgrade the laboratory's collaborations and to keep the good scientific level.

CONCLUSION

From the sequence of the listed educational institutions, BAS institutes and scientific groups, it is obvious that Assoc. Prof. Dr. Tsyntsarski had the chance to study and work in the most prominent centers of chemistry in Bulgaria under the supervision, and later on in collaboration, with world-renowned scientists in the field of chemistry. In confirmation, the applicant's active publication activity and high citation rate can be indicated. His h-index is 17, when is required

10. In my opinion, the response in the scientific literature of the candidate's scientific research is impressive. Obviously, he is visible, recognizable, quotable, which is indisputable evidence that he works in a current scientific field.

The documents and materials presented by Assoc. Prof. Dr. B. Tsyntsarski fulfill all requirements of the Act for the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), the Regulations for the application of the ADASRB, the Regulations for the conditions and the procedure for acquiring academic degrees and for taking Academic positions at BAS and the Regulations for the conditions and procedure for acquiring scientific degrees and for occupying academic positions at IOCCP-BAS.

The applicant in the competition has submitted a significant number of articles published after his defense. His works contain original scientific and applied contributions that have received international recognition, a representative part of which has been published in journals and proceedings issued by international academic publishing houses. The theoretical knowledge of the applicant has practical applicability. The scientific qualification of Assoc. Prof. Dr. Boyko Tsyntsarski is unquestionable.

Achievements of Assoc. Prof. Dr. Boyko Tsyntsarski results in the scientific research activity **totally correspond** to the specific requirements of the regulations of the IOCCP- BAS for the application of ADASRB. After getting familiar with the materials presented in the competition, I **strongly recommend** to the Scientific Jury to prepare a report-proposal to the Scientific Board of IOCCP-BAS to award to

Associate Professor Dr. Boyko Georgiev Tsyntsarski

the academic position of "Professor" in the field of chemical sciences, code 4.2. Scientific specialty "Organic chemistry".

Prepared by:

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/Prof. Dr. Maya Stefanova/

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