**REVIEW**

**by Prof. Dr. Denitsa Yancheva Pantaleeva, Institute of Organic Chemistry with Centre of Phytochemistry - BAS**,

on the materials submitted for participation in the competition
for the academic position of Associate Professor at the Institute of Organic Chemistry with Centre for Phytochemistry (IOCP), BAS
in the field of higher education "Chemical Sciences",
professional field - 4.2, scientific specialty "Organic Chemistry"

In the competition for "associate professor", announced in the State Gazette, issue 27 of 05.04.2022 and on the Internet page of IOCCF, BAS, as a candidate participates Senior Assist. Prof. Dr. Ivanka Georgieva Stoycheva from IOHCF-BAS.

***1. General presentation of the materials received***

For participation in the announced competition only one candidate has submitted documents: Senior Assist. Prof. Ivanka Georgieva Stoycheva from IOHCF-BAS. The submitted set of documents submitted by Senior Assist. Prof. Ivanka Stoycheva is in accordance with the Regulations for the Development of the Academic Staff of the IOHCF, and meets the criteria of the IOHCF-BAS for holding the academic position of Associate Professor. A summary of the fulfilment of the minimum requirements, a summary of the scientific contributions, a list and copies of the scientific works under the competition (20 in total, corresponding to the scientific specialty of the competition), as well as an abstract for obtaining the PhD degree and materials certifying the candidate's participation in scientific projects, conferences, etc. are attached. The submitted materials are well formatted and clearly present the candidate's previous scientific activities and achievements.

Senior Assist. Prof. Ivanka Stoycheva participates in the competition with a total of 20 scientific publications, distributed according to the rank of the scientific journals, expressed in quartiles (Q-factor), as follows: 4 publications in scientific journals with *Q1*; 6 publications in scientific journals with *Q2*; 1 publication in a scientific journal with *Q3*; 5 publications in scientific journals with *Q4* and 4 publications in refereed journals with SJR without IF. Six of these publications were submitted under group B of the indicators (equivalent to a Habilitation paper). The remaining 14 research papers are presented under group D of the indicators. In

accordance with the requirements of the IOHCF Academic Staff Development Regulations for the academic position of Associate Professor, the candidate's *h*-index is 5 according to the information in the *Scopus* scientific database, after exclusion of the self-citations.

***2. Brief biographical details of the applicant***

Senior Assist. Prof. Dr. Ivanka Stoycheva has completed her higher education at the University of Chemical Technology and Metallurgy, Sofia. In 2012 she obtained a Bachelor's degree in Engineering Ecology and Environmental Protection, and in 2013 a Master's degree in Natural and Synthetic Fuels. In 2016, Ivanka Stoycheva defended her PhD thesis on "Synthesis of carbon materials based on organic compounds" under the supervision of Prof. Dr. Temenuzhka Budinova at the Institute of Organic Chemistry with Centre of Phytochemistry - BAS. Ivanka Stoichea continues her scientific career at the IOHCF-BAS: as Assistant Professor (2016-2019) and Senior Assistant Professor (since 2019) in the Laboratory "Chemistry of Solid Fuels".

***3. Evaluation of the candidate's scientific and applied activity***

The submitted scientific works for participation in the competition show that the research activity and the scientific interests of Senior Assist. Prof. Dr. Ivanka Stoycheva are in the field of technology of natural and synthetic fuels and are focused on the following main directions:

- development of methods for conversion of selected organic wastes to useful liquid, gas and solid products;

- analysis of the chemical composition of organic wastes in order to select the most suitable ones for processing into useful products and characterisation of the carbon materials obtained after processing;

- determining the applicability of the resulting solid products as carbon adsorbents for water treatment of toxic organic and inorganic pollutants, hydrogen storage for fuel, catalyst supports in various reactions, etc.

In the *Report about the Scientific Contributions* presented by the candidate, these areas are discussed extensively in the light of environmental protection and in particular the conversion of organic wastes from agricultural and industrial production to useful products and their use as energy sources and as carbon adsorbents for the purification of water and air from various pollutants. As mentioned above, 6 of the publications for the competition were submitted as the equivalent of a Habilitation paper, and provided the candidate with a total of 104 points in Group

B of the required indicators. The research has been published in international journals (*Elsevier's Diamond* and *Related Materials and MDPI's Applied Science*) and Bulgarian scientific journals (*Comptes rendus de l'Acad´emie bulgare des Sciences* and *Bulgarian Chemical Communications*), mainly in the last 3 years, with the candidate being first author in 5 out of the 6 publications. The other part of the research papers of Dr. Ivanka Stoycheva, presented in group D of indicators, accounts for 231 points in this group of indicators. Here again the publications cover a wide range of international and Bulgarian journals - *Applied Surface Science, International Journal of Hydrogen Energy, Inorganics MDPI, Journal of Material Cycles and Waste Management, Oil Shale, Polymer International, Bulgarian Chemical Communications and International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management*. The scientific papers in this category were published in the period from 2017 to 2022 and in three of them, the head as. Dr. Stoycheva is again the first author. All scientific papers submitted by the candidate for this competition are co-authored, published in English.

The research of Senior Assist. Prof. Dr. Ivanka Stoycheva falls within field of intense scientific interest, as can be judged on the basis of the significant number of independent citations for all published scientific works of the candidate - a total of 88 citations, as indicated by the scientific database *Scopus* at the time of the review (after excluding the sel-citations of all co-authors). More than half of the citations are in the last three years (2020-2022). For the purposes of this competition, 69 citations were submitted – all of them in scientific journals referenced and indexed in *Web of Science* and *Scopus*, which provided the candidate with 138 points and almost double the required minimum of 70 points.

The research activity of the candidate is also supported by a very extensive presentation of the achieved results to the scientific community - Senior Assist. Prof. Dr. Ivanka Stoycheva has participated in 77 conferences (23 oral reports and 54 poster presentations).

So far, head as. Dr. Ivanka Stoycheva has been the leader of two scientific projects - a project for young scientists and postdoctoral fellows approved by the National Scientific Fund of Bulgaria in 2019 and a project for young scientists under the National Program "Young Scientists and Postdoctoral Fellows" of the Ministry of Education and Science (for the period from 2018 to 2021). She has also been a member of the team of 12 other research projects funded by Bulgarian and international sources, including the Operational Programme “Science and Education for Smart Growth”, co-financed by the EU through the European Structural and Investment Funds, the EU Horizon 2020 programme, the ERF, ITU NOVA - Istanbul, Turkey, and the Academic

Exchange Programme (EBR) in the framework of the cooperation between the Bulgarian Academy of Sciences, the Romanian Academy of Sciences and the Polish Academy of Sciences.

The main contributions of the scientific activity of Senior Assist. Prof. Ivanka Stoycheva PhD can be summarized as follows:

(i) A method for processing mixed organic waste to liquid and gaseous products (suitable for use as energy sources) and a solid product (carbon adsorbent with developed porous structure) has been developed. Waste products from a variety of industrial and household industries were used as starting material: polymer roof coatings (roofing PVC and bitumen mulch), furfural - waste biomass, polyethylene and phenol formaldehyde resins, tar fraction - waste product from coal coking, etc., which gives the candidate's research, in addition to the fundamental scientific contribution, undoubtedly an applied character.

The processing method is based on thermal oxidation by heating and treatment with an oxidant (concentrated sulphuric acid, nitric acid), followed by various pyrolysis steps at 600°C ('green' carbon foam) and hydropyrolysis at high temperature (750-1000°C). It was found that optimization of the processing - varying the initial mixture and oxidizing agent - allowed to adjust the properties of the resulting carbon adsorbents and to obtain carbon foam with an ordered porous structure and high mechanical strength.

In the developed conversion method, the use of high pressure and additional stabilization treatment is avoided, which simplifies the approach, reduces the energy consumption and makes the process more economical efficient. The development of the method and the synthesis of the carbon materials are described in publications V1-V6 and G6 of the candidate and the contributions can be attributed to the creation of new technologies.

(ii) The detailed physicochemical characterization of the obtained carbon materials by modern analytical methods - elemental analysis, nitrogen physisorption, infrared and Raman spectroscopy, scanning electron microscopy, ultraviolet spectroscopy, X-ray diffraction, thermochemical methods, etc. has demonstrated that the carbon adsorbents have highly developed surface area and significant content of micro- and mesopores. Based on the collected data on the properties of the carbon materials, the mechanism of structure and texture formation has been established. The influence of the thermochemical processing conditions on the content of various oxygen-containing functional groups on the surface of the carbon materials is specified. It is also shown that activation with water vapour at high temperature leads to a significant increase in the surface area and pore volume, especially of the micro-sized pores.

The physicochemical characteristics of the obtained materials have contributed to the successful determination of the optimum processing conditions for the raw materials and have served as a basis for finding possible application areas. These contributions can be found in all the publications presented by the candidate and can be attributed to the enrichment of the existing scientific knowledge on the properties and mechanism of formation of carbon materials.

(iii) Possible areas of application of the carbon materials derived from waste products have been outlined through their pilot application for water purification from various toxic pollutants such as phenols, dyes, heavy metals (described in publications G1, G12, G13); hydrogen storage for fuel (described in publications G4, G5, G9, G11); catalyst supports in various reactions (described in publications G3 and G8); preparation of high hardness composites (described in publication G2), etc. The contribution of these studies can be attributed to the establishment of a new scientific field - more efficient utilization of waste products and their conversion into high calorific fuels and carbon adsorbent with valuable properties.

***4. Evaluation of the personal contribution of the candidate***

The contribution of the candidate in the conducted research can be evaluated as significant, and in a part of it (in the works presented as an equivalent of Habilitation thesis - V1-V4, V6, as well as in publications G8, G12 and G13) - as the leading one, which is evidenced by the first position of the Senior Assist. Prof. Dr. Ivanka Stoycheva in the author list and her role as a corresponding author, as well as the contributions declared by the co-authors themselves in some of the publications. The candidate in the competition has undoubtedly developed the necessary scientific competence and skills for the synthesis of carbon materials, studying their properties in order to improve or modify the methods for their synthesis, determining the structure and texture of the materials in relation to their possible applications and last but not least - finding areas of application of the developed materials of current scientific interest. This acquired competence has also defined the future development directions of the candidate, formulated in the *Report on Scientific Contributions* as a continuation and extension of the previous area of research, namely: development of new methods for synthesis of carbon adsorbents; expansion of the raw material base for the preparation of carbon materials by incorporating glassy carbon, graphene, carbon nanotubes, etc.; development of methods to modify the surface of the carbon adsorbents in order to obtain surface properties enabling the extraction of a particular pollutant depending on its chemical properties; continuation of the research into other areas of application of the carbon materials such as hydrogen storage, electrodes for batteries, adsorbents for various bacteria and viruses. As a perspective for development of this research, Senior Assist. Prof. Dr. Ivanka

Stoycheva has declared a willingness to seek funding from national and international programmes - a prospect that seems justified given the extensive experience of the candidate and his colleagues in the Laboratory of Solid Fuel Chemistry in the management and participation in research projects to date.

***5. Critical comments and recommendations***

I have no critical remarks to the materials presented by the Senior Assist. Prof. Dr. Ivanka Stoycheva in the current competition for the academic position of Associate Professor at the Institute of Organic Chemistry with Centre of Phytochemistry, BAS. In the light of the promising scientific results on the preparation of carbon materials with modified properties and the broad prospect of their practical application, I recommend the candidate to focus his efforts also in the direction of registration of a utility model or other type of protected product with practical orientation.

***6. Personal impressions***

In the course of my personal contacts with Senior Assist. Prof. Dr. Ivanka Stoycheva, I have developed excellent impressions about her professional qualities - she is a promising young specialist in her field, as well as about her personal skills to work in a team and to actively participate in the scientific and organizational activities of her laboratory and the institute.

**CONCLUSION**

The documents and materials, presented by Senior Assist. Prof. Dr. Ivanka Stoycheva comply with all the requirements of the Law for the Development of Academic Staff in the Republic of Bulgaria, the Regulations for the Implementation of the Low, the Regulations for the Implementation of the Low at BAS and the Regulations of the IOHCF-BAS.

In terms of their volume and quality, all the scientific metrics of Senior Assist. Prof. Dr. Ivanka Stoycheva meet and exceed the recommended requirements for the academic position of Associate Professor. In the candidate's works there are original scientific and scientific-applied contributions that have received international recognition – her scientific works have been published in Bulgarian and international academic journals and have a significant number of citation by other authors. The obtained scientific results have a good perspective for practical

applicability. The own contribution to the research and the acquired scientific competence of Senior Assist. Prof. Dr. Ivanka Stoycheva are undoubted.

After evaluating the materials and scientific works presented in the competition, analysing their significance and the scientific and applied contributions contained in them, I confidently give my positive assessment of the candidate and recommend the members of the Scientific Jury and the Scientific Council of IOCCF-BAS to support the election of Senior Assist. Prof. Dr. Ivanka Stoycheva to the academic position of Associate Professor in the field of higher education "Chemical Sciences", professional field - 4.2, scientific specialty "Organic Chemistry".

19.08.2022 г. Reviewer:

(Prof. Dr. Denitsa Yancheva Pantaleeva, Institute of Organic Chemistry with Centre of Phytochemistry - BAS)