

OPINION

by Prof. Dr. Ivanka Spassova, Institute of General and Inorganic Chemistry - BAS,

on the materials submitted for participation in a competition for the academic position of "Professor" in professional field 4.2 "Chemical sciences" (Solid State Chemistry) for the needs of the laboratory "Electron spectroscopy of solid surfaces" IGIC- BAS, promulgated in SG no. 46 of 26. 05. 2023

In the competition for the academic position of "Professor" in the "Electron Spectroscopy of Solid Surfaces" laboratory announced by the IGIC-BAS, the only candidate is Assoc. Prof. Dr. Ivalina Avramova. The submitted materials for participation in the competition are in accordance with the Regulations for the terms and conditions for acquiring scientific degrees and for holding academic positions at the IGIC- BAS and include all the necessary documents. Associate Professor Dr. Ivalina Avramova is registered at NACID (<https://ras.nacid.bg/dissertation-preview/26779>), where her educational and scientific degree of doctor and the academic position of Associate Professor are recognized.

Brief details of the applicant

Prof. Dr. Ivalina Avramova graduated in 1996 Sofia University St. Kliment Ohridski, Faculty of Physics, Engineering physics major. In the same faculty, she defended her doctoral dissertation on the theme: "Electronic properties and thermoelectric efficiency of $\text{Ge}_{1-x}\text{Ag}_x/2\text{Bi}_x/2\text{Te}$ solid solutions". Since 2001, she has been working at IGIC-BAS, successively as a Physicist, Assistant and Chief Assistant, and in 2012 she was elected Associate Professor at the same institute.

Evaluation of the scientific and scientific-applied activity

The indicators of Assoc. Dr. Ivalina Avramova, presented in the reference for minimum requirements of BAS and IGIC, according to the Regulations for the terms and conditions for acquiring scientific degrees and for holding academic positions at IGIC – BAS, exceed the required ones, although according to indicator E the evidence is incomplete.

Assoc. Prof. Dr. I. Avramova is a co-author of 125 scientific papers, and in the current competition she participated with 65 scientific papers, all after her habilitation in 2012. Fifteen of the publications are in journals indexed with quartile Q1 (some of them have been published in Applied Surface Science, Journal of Chemical Physics, Thin Solid Films, Journal of Alloys and Compounds, etc.), 17 in Q2, 11-Q3, 6 in Q4 as well as 16 publications with sjr. 341 citations were noticed on the publications of Assoc. Prof. Dr. Avramova after her habilitation. Results of the scientific research carried out with the participation of Dr. Avramova were presented with 43 posters and 8 reports at national and international scientific forums. Dr. Avramova presented a list of participations in 8 national and 5 international projects. Her Hirsch index according to Scopus is 16.

Scientific contributions

The Habilitation Report of Assoc. Prof. Dr. Avramova is based on the results of 10 scientific publications, thematically uniting studies with X-ray photoelectron spectroscopy of layers of graphene and graphene-like phases, graphite, carbon black and their modifications.

The contributions can be summarized as:

- By determining the relative amount of carbon atoms with sp^2 and sp^3 hybridization, it was found that graphene layers deposited on SiO_2 consist mainly of single layers of defective graphene, while on diamond-like carbon DLC of several layers of polygraphene.
- Argon plasma treatment was found to affect the structure and quality of deposited graphene layers, leading to an increased content of sp^3 -hybridized carbon on the surface, accompanied by an increased amount of oxygen-containing functional groups.
- The possibility of depositing graphene and graphene-like phases on commercial metal foils has been demonstrated, and the type of substrate has been found to influence the layers and quality of graphene.
- Deposition of graphene and graphene-like phases on Si(001), as well as the presence of different interlayers between Si-substrate and graphene was demonstrated by determining sp^2 and sp^3 -hybridized carbon. The amount of sp^3 and sp^2 hybridized carbon is found to be affected by the surface morphology of the layers.
- By determining the amount of sp^2 and sp^3 hybridized carbon atoms, an evaluation of graphene layers obtained by two regimes of pulsed laser deposition (PLD) deposited on $SiO_2/(001)Si$ substrates was made. It was found that pulsed deposition with a lower laser flux is more promising for obtaining a thin and high-quality graphene layer.
- For the first time, the D-parameter (the distance between the most positive maximum and the most negative minimum of the first derivative of the C-KLL spectrum) was used to estimate the sp^3/sp^2 ratio in carbon layers obtained in continuous and pulsed PLD mode. It was found that a continuous process deposited graphene with a greater thickness, and a pulsed mode deposited single- to several-layer nanosized graphene. In both processes, an interface enriched in sp^3 hybridized carbon is recorded.
- The sp^3/sp^2 hybridized carbon ratio of deposited carbon thin films by plasma-enhanced CVD (PECVD) was found to increase under UV light treatment in all nanosized graphene layers under parallel irradiation of the layer surface and to decrease significantly when the irradiation is perpendicular to the surface of the layers.
- It was found that nanoscale carbon phases (graphene, defect graphene, rGO and GO) and bundles of graphene-like flakes can be obtained from two types of microcrystalline graphite suspensions by pulsed laser ablation (PLA) in flow.
- Through the analysis of XPS spectra, the influence of chemical treatment with acetone, toluene and phenol on the structure and morphology of the carbon phases of two types of graphite and two types of carbon black was evaluated. The changes in the graphite materials after treatment with the various chemical reagents are weak and mainly affect the content of oxygen-containing functional groups on the surface. A strong change of the sp^2/sp^3 ratio and oxygen content was observed in both types of carbon black.

The research presented in the Habilitation report shows that XPS studies of layers of graphene and graphene-like phases, graphite and carbon black can serve as a measure of the successful preparation of these materials, as well as for the optimization of the synthesis and processing conditions.

The report for the contribution of Assoc. Prof. Dr. Ivalina Avramova on the non-habilitation publications for participation in the competition is built on 55 scientific works. The research is related to the application of the XPS method for the study of catalysts and photocatalysts,

protective coatings, glasses and glass ceramics, thin layers, organic materials, carbon allotropes and phases, etc.

CONCLUSION

The documents and materials presented by Assoc. Prof. Dr. Ivalina Avramova meet the requirements of Law for the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the Regulations for its Implementation and the relevant Regulations of the Institute of General and Inorganic Chemistry, BAS. There is a sufficient number of scientific works published after the habilitation. The results achieved by Associate Professor Dr. Ivalina Avramova in her research activities reveal her as an experienced scientist with a subject related to the application of X-ray photoelectron spectroscopy in designing of materials for various applications.

Based on the above, I give my positive assessment of the overall research activity of Assoc. Prof. Dr. Ivalina Avramova and recommend to the members of the Scientific Jury and the Scientific Council of IGIC-BAS to award Assoc. Prof. Dr. Ivalina Avramova the academic position "Professor" in the field 4.2. Chemical Sciences (Solid State Chemistry).

05.09.2023

Member of the Scientific Jury:

(Prof. Dr. Ivanka Spassova)