

# R E P O R T

## **on the competition for the academic position Associate Professor scientific direction 4.2. Chemical Sciences (Inorganic Chemistry)**

at the Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences  
(IGIC-BAS)

announcement in ДБ - 36 - 03.05.2019

Applicant: **Assistant Prof. Dr. Lyubomir Ivov Aleksandrov** (IGIC-BAS)

Member of the Scientific Jury: Prof. Dr. Radostina Konstantinova Stoyanova (IGIC-BAS)

### **A. Short professional biography**

Dr. Lyubomir Aleksandrov is the only candidate in the competition for the academic position associate professor in Chemical Sciences (inorganic chemistry) announced by IGIC-BAS. He graduated with a master's degree from the University of Chemical Technology and Metallurgy - Sofia in 2004, specialty Silicate Materials. In 2009 he defended his doctoral dissertation in the field of inorganic chemistry on "Synthesis and structure of amorphous and polycrystalline molybdate phases containing oxides of rare earth elements". Since 2009 he has been employed at IGIC-BAS as a chemist, and since 2012 - he has held the position of Assistant Professor. An important step in the research advancement of Dr. Aleksandrov in the field of synthesis and structural characterization of inorganic glass materials is his post-doc specialization in a number of authoritative international scientific organizations such as the Technical University of Vienna (Austria), Nagaoka University of Technology (Japan) and Friedrich Schuler University in Jena (Germany). Dr. Aleksandrov effectively uses the acquired new knowledge to expand his research activity in the Laboratory of High Temperature Oxide Materials at IGIC-BAS in the direction of linking the synthesis and structure of materials with their properties and applications. This report reveals unambiguously that Dr. Aleksandrov fully complies with the requirements of the competition announced in IGIC-BAS for Associate Professor in Chemical Sciences (Inorganic Chemistry).

### **B. Report on the fulfillment of the minimal criteria of BAS**

Dr. Aleksandrov is a co-author of a total of 62 scientific papers. He participated in the competition for associate professor with 10 scientific publications, summarized as a habilitation thesis. They are devoted to the study of the processes of glass formation, liquid-phase separation and crystallization in non-traditional glasses. Nine of them have been published in international journals with an impact factor, and three are in journals from the first quartile in the field of chemistry, such as the Journal of Non-Crystalline Solids. Along with them, Dr. Aleksandrov presents 20 scientific publications, which are focused on the development of amorphous hybrid materials by applying the knowledge on glass formation processes and crystallization. It is of importance that 8 papers of them were published in international journals from the first quartile in the respective fields. So far, 191 independent

citations have been noticed on Dr. Aleksandrov's scientific publications. Dr. Aleksandrov presented some of the research results to 53 scientific forums, 35 of which are international. The successful research activity of Dr. Aleksandrov is possible thanks to his active participation in 16 contracts funded by various sources, two of which he is the leader of: one under the Science and Business Program at the Ministry of Education and Science and one from the Japanese Society for Prospective Scientists. The total Hirsch index (H-factor) of the overall scientific output of Dr. Aleksandrov is 10.

The report analysis reveals that Dr. Aleksandrov's scientific output covers the subject of the competition and exceeds at about three times the minimal national requirements for occupation of the academic position of associate professor in the field of Natural Sciences, Mathematics and Informatics, Direction of Chemical Sciences, mentioned in The Law for the Development of the Academic Staff in Bulgaria, the Regulations for its Implementation and the Rules for the Conditions and Procedures for Acquisition of Academic Degrees and Holding of Academic Positions at IGIC-BAS: from the required minimum 500 points, the candidate has 1483 points.

### **C. General features of the applicant's research activities**

***C1. Main scientific contributions presented in the habilitation thesis.*** The formation of glasses between immiscible oxides is a fundamental scientific task with significant applied potential for the elaboration of more efficient optical materials, as well as for the immobilization of hazardous waste. Dr. Aleksandrov's research falls into this modern field. Scientific contributions can be divided into two groups depending on the field of application of the glasses.

- *Optical glass materials:* through a complementary using of spectroscopic (such as IR, Raman and X-ray photoelectron spectroscopy) and thermal methods, it is proposed new structural models describing the amorphous network (local and medium order) of molybdate, tungsten and mixed molybdate-tungsten glasses, containing the classical  $B_2O_3$  and rare earth elements or ZnO. The polyhedra of rare earth elements or zinc have been shown to play a major role in the formation of homogeneous amorphous networks between the molybdate/tungstate and borate constituents of glasses. The new gained knowledge on the local structure of molybdenum and tungsten in glasses is directed towards the understanding the processes of liquid-phase stratification and crystallization. As a result, it has been found the most suitable thermal regimes for obtaining glass-crystalline phases with different degrees of crystallinity such as  $LaWBO_6$ ,  $LaMo_{x-1}W_xBO_6$ ,  $\alpha-ZnMoO_4$ . The doping of the glass-crystalline phases with  $Eu^{3+}$  turns them into phosphors with intense red luminescence.

- *Immobilization of radioactive waste:* Searching for elaboration of approach for immobilization of high molybdenum waste from nuclear power plants by glazing, the liquidation processes in the model system  $MoO_3-SiO_2-B_2O_3-Na_2O-ZnO-Nd_2O_3$  have been explored. It has been demonstrated that the formation of  $Na_{0.5}Nd_{0.5}MoO_4$  instead of the water-soluble  $Na_2MoO_4$  during the cooling of the melts can have a positive environmental effect.

In conclusion, the research of Dr. Aleksandrov contributes, on the one hand, to the enrichment of knowledge in the field of chemistry of inorganic glasses, and on the other – they give impetus to the study of the relationships between glass structure and the processes of phase separation and crystallization.

**C2. Scientific contributions presented in the non-habilitation thesis.** The background of these studies is the synthesis, structural and thermal characterization of amorphous hybrid materials. One class of materials is based on SiO<sub>2</sub> / biopolymer and SiO<sub>2</sub> / polysaccharides / Me (Me = Ag, Cu or Zn). Original approaches for homogeneous networking between organic and inorganic components, as well as for insertion of metal ions with antibacterial activity and biocompatibility, have been developed. The hybrid materials exhibited varying degrees of cytotoxicity and showed interesting properties as antibacterial agents. Another class of materials is boro-silicate glasses containing nanoparticles of gold or silver. It was found that the shape and size of the nanoparticles in the glasses depend on the conditions of laser treatment, which in its turn allows achieving specific optical properties of hybrid materials (plasmons, photon, sensor, etc.).

These studies were carried out jointly with researchers from IGIC-BAS, UCTM-Sofia and the Institute of Electronics at BAS. The role of Dr. Aleksandrov in them is clearly outlined - starting from planning of research tasks reaching to interpreting the results via performing experiments to obtain and characterize glass-based materials.

#### **D. Conclusion**

A distinctive feature of the research activity of Dr. Lyubomir Aleksandrov is the systematic study of the processes of crystallization and liquid-phase separation in complex oxide systems. The research of Dr. Aleksandrov reveals new approaches to the formation of glass between immiscible oxides, as well as provides new data on the relationships between local structure, thermal and optical properties of glasses. They can also provide new guidelines for the study of amorphous hybrid materials. The scientific output of Dr. Aleksandrov exceeds significantly the minimal national requirements for occupying the academic position of Associate Professor in the field of Natural Sciences, Mathematics and Informatics, Direction on Chemical Sciences, specified in the Bulgarian law, and in particular in the regulations of IGIC-BAS. Based on the above-mentioned criteria, I propose in most convincing way that the Scientific Jury to award Dr. Lyubomir Aleksandrov the Academic Position Associate Professor in Inorganic Chemistry.

10.03.2021 г.

Radostina Stoyanova