REVIEW

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on the competition for the academic position "assoc. prof." in the professional field 4.1 "Physical sciences", scientific specialty "Electrical, magnetic and optical properties of the condensed matter", published in the Newspaper of State No. 35/10.05.2022 by IOMT-BAS

Candidate: assist. prof. Katerina Emilova Lazarova, Ph.D., IOMT - BAS

Assist. prof. Katerina Emilova Lazarova is the only candidate applying for the academic position "associate professor", announced by IOMT-BAS. For the competition, the candidate has provided a full set of documents under the Regulations for the implementation of the Law for the development of the academic community in the Republic of Bulgaria. The documents provide comprehensive information about the academic activity of Katerina Lazarova.

1. Brief biographical data

Katerina Lazarova is a graduate of the Faculty of Physics of the University of St. Clement Ohridski". She obtained her M.Sc. degree in " Physics" in 2006. Within the period 2013-2015, she was a full-time Ph.D. student at IOMT under the supervision of prof. Ts. Babeva. In 2015 she successfully defended a Ph.D. thesis entitled "Porous one dimensional photonic crystals from metal oxides and nanosized zeolites for sensory applications". From 2016 to 2017, she held the academic position of "assistant" at IOMT, and from 2017 up to now – a position of "assist. prof. " at the same institute. Within the period 2012-2014, she conducted two specializations of one month at CERN (HST Program 2012) and the Laboratory of Catalysis and Spectroscopy (LCS), Caen, France, in the field of zeolites synthesis, Operando, and InSitu spectroscopy.

2. General description of the presented materials

The overall scientific production of assis. prof. Katerina Lazarova includes 41 scientific papers, of which 25 are in publications with impact factor and impact rank, one is a popular science article, and 9 are related to her Ph.D. thesis. To date, all these works have been cited 110 times in the Web of Science and Scopus databases, and her H-Index is currently 6.

Assis. prof. Katerina Lazarova participated in the competition with 20 publications, published after obtaining her Ph.D. degree, 6 of which are equated to a habilitation thesis (group of indicators "B", indicator "4"), - 117 points, and the rest 14 papers are unified under group "G", indicator "7" - a total of 230 points.

The papers, selected for participating in the Associate Professor competition can be classified as follows:

By type:

- Publications in scientific peer-reviewed journals – 20;
- Publications in conference proceedings – 0;
- Popular science publications - 0;

By importance (quartile by SJR op JCR)

- Papers in Q1 ranked journals- 7 (papers #2, 3, 6, 15 , 16 , 18 and 19 from the general list);
- Papers in Q2 ranked journals - 3 (papers #5, 13, and 14 from the general list);
- Papers in Q3 ranked journals – none ;
- Papers in Q4 ranked journals - 6 (papers #4, 7, 8, 9, 11, and 17 from the general list);
- Papers in journals with SJR rank - 4 (papers #1, 10, 12, and 20 of the general list);
- Papers in journals without quartile and SJR rank - none.

It should be noted that the majority of the papers are published in top Q1 and Q2 ranked journals in the field of material science, which is a good certificate for the actuality and the level of her research.

Katerina Lazarova presents a list of 31 citations of the candidate's works reflected in the Web of Science and Scopus databases. They accumulate a total of 62 points according to metrics of the group of indicators "D", indicator "11". From the reference list (Appendix 3-4) for performance on the minimum requirements, it is seen that the candidate collects a total of 459 points with the required minimum of 430 points according to the IOMT-BAS Rules.

The presentation of the candidate's research results is impressive. Katerina Lazarova has taken participation in a significant number of international and national scientific forums (a total of 61, from which a large part are abroad and online), where she presented 38 reports and 23 posters. Two of them were awarded the distinction for the best poster presentation and three of them – for the best report.

According to the attached reference list, Katerina Lazarova has also participated in a large number of scientific projects and contracts - a total of 13, of which she was the supervisor of 3. During this period, she was awarded a certificate for achieved results and successful performance on project DFNP-17-97 under the Program for assistance on young scientists and Ph.D. students -BAS. In addition, she won 1st place in the IOMT competition under the NATIONAL PROGRAM Young scientists and postdoctoral students, for a 3-year postdoctoral scholarship (2019-2021).

3. Research activity of the candidate

The scientific activity of assist. prof. Katerina Lazarova is mainly focused on the development of new materials for optics and their application as optical sensors for humidity or volatile organic compounds. Her work in this period is aimed at obtaining thin layers of polymers, zeolites, or composites on metal oxides, finding the conditions for the deposition in the form of thin films, their complete characterization with different techniques, and the study of their sensing properties. Her research can be grouped thematically into the following directions:

I. Investigation of the optical and sensing properties of thin films of different humidity sensitive polymers - publications No. 1÷ 5, 20;
II. Development of a flexible humidity sensor with optical detection - publication No. 6;
III. Characterization of the optical and sensing properties on nanocomposites of metal oxides and zeolites - publications No. 7, 9, 12, 15, 16, 18;
IV. Development of Brag stacks of metal oxides and/or composites - publications No 8, 10, 13, 14;

V. Optical characteristics of ZrO_2 thin films obtained by different synthesis and doped with rare earth elements - publications No 11, 17, 19

In the literature, there are only a few examples of sensors that work entirely based on changing the color of the sensor, without electricity or other connecting technology, which are easy to use and do not require regeneration. The scientific contributions as a result of the research, carried out by the candidate, are related to the successful selection of sensitive materials and their implementation in humidity detection technology working on the principle of color change. They can be summarized as follows:

Direction I:

- For the first time, the possibility of using thin films of copolymers of poly (N, N dimethyl acrylamide) and poly (ethylene oxide) DMAA/PEO) with different compositions and structures as sensitive media for optical humidity detection has been successfully demonstrated. The influence of the polymer structure and the annealing temperature of the films on their optical response has been established.
- For the first time, the relationship between the chemical composition/macromolecular architecture and the optical and sensing properties of block copolymer thin films containing poly(N, N-dimethyl acrylamide) has been established. The most suitable polymer for optical humidity detection is shown to be one with a branched macromolecular architecture, which achieves an optimal balance between sensitivity and hysteresis.
- Doubly hydrophilic copolymers with complex branched structures containing blocks of poly(N, N -dimethyl acrylamide) and poly(ethylene oxide) have been successfully used as humidity-sensitive optical media. A resolution achieved is very close to the best resolution in optical humidity detection reported in the literature so far. Successful detection of color change at varying humidity in the case of a sensing polymer layer deposited on top of a Bragg stack and on metalized glass in transmission mode is also demonstrated.
- The ability of thin films of four different hydrophobically modified PVA copolymers (poly(vinyl alcohol-co-vinyl acetal)) with different copolymer compositions to be used for optical humidity detection has been demonstrated. An improvement of the sensing properties has been achieved through the use of hybrid thin films of acetal-modified PVA polymers with added silica.

Direction II:

- A flexible and transparent polymer-based optical humidity sensor has been successfully developed, operating without the need for electricity and obtained by a relatively simple and inexpensive method. The sensor consists of a pre-metalized PET substrate coated with a thin film of acetal-containing poly(vinyl alcohol-co-vinyl acetal). The influence of up to 1000 bending strains on the surface morphology and optical quality of the sensor is negligible.

Direction III

- The possibility of controlling the optical thickness of zeolitic Si-MFI films by changing the concentration or deposition rate during film deposition is demonstrated. The

possibility of using them as an antireflection coating for a wide spectral range by depositing zeolite layers of a certain thickness on both sides of a glass substrate is shown.

- Optimization of the optical and sensing properties of Nb_2O_5 and SiO_2 films was achieved by doping with EMT and MFI crystalline zeolites. The possibility of varying the refractive index of the Nb_2O5 composites within very wide limits by changing the zeolite quantity has been established, which gives an exceptional potential for application.
- For the first time entirely optical detection of acetone/acetone vapor by Nb_2O_5 thin films doped with FAU-type fly ash zeolites (Na-X phase) has been demonstrated. It was shown that by wet milling of zeolites from coal ash Na-X, the sensing properties of thin zeolite/ Nb_2O_5 composite films can be changed in the desired direction.
- For the first time was demonstrated in situ deposition of thin films of FAU-CuO modified zeolites from coal ash by crystallization under the influence of magnetic homogenization and ultrasound. Their potential for optical detection of contaminants in the gas phase (acetone) was demonstrated.

Direction IV

- The possibilities for the controlled deposition of thin layers of Nb_2O_5, V_2O_5, and Ta_2O_5 by the sol-gel method, as well as their mesostructuring, have been demonstrated. The porous films were found to be suitable for use as an active medium for the optical detection of acetone vapor.
- A more than 10-fold increase in sensitivity to acetone vapor was achieved using a 7-layer Bragg stack constructed of porous and dense layers of low and high refractive index Nb_2O_5 films. The introducing a "defective, porous" layer into the stack leaded to a significant improvement in response over a stack without a "defective" layer.

Direction V

- Homogeneous, thin, and high optical quality ZrO_2 films and those doped with Sm were successfully obtained by varying different additives in the sol-gel method. It was found that Sm-doped ZrO_2 films are characterized by a very high acceptor /donor ratio photoluminescent emission, which makes them a promising candidate for applications in the field of photonics and in particular for the production of white LEDs.

4. Assessment of the personal contribution of the candidate

The articles presented by the candidate are collective works, including several authors. This is typical of modern scientific research involving scientists from different institutions in different countries. Taking into account the fact that K. Lazarova is the first author in a total of 10 of the presented articles, as well as my impressions on the applicant's qualities, I consider that she has a significant personal contribution, both in terms of ideas and in the specific conduct of research and the shaping of the results for publication. I have known Katerina Lazarova since she started working at the Institute, I have witnessed her scientific growth and can appreciate her contribution.

5. Conclusion

The publications, presented by the candidate assist. prof. Katerina Lazarova, are on the subject of the competition and represent original scientific developments with a contribution in the field of optical properties of condensed materials. A total of 41 citations in the international literature of the publications with which the candidate participated in the competition, despite the short time elapsed since their publication, were noted. This is a indication of both the relevance of the scientific topic and the significance of the results obtained by the candidate. The attached materials give me a reason to believe that the candidate is an established scientist in his field with deep knowledge and practical skills in the application of a wide range of experimental approaches to the preparation and characterization of inorganic and organic compounds. The obtained results are innovative and belong to the category of novelties in scientific research. They provide a basis for further research in the field of developing new materials for optics and their application as optical sensors for humidity or volatile organic compounds. The candidate demonstrates creative thinking and maturity in selecting tasks of relevance to science and practice.

In conclusion, I am convinced that scientific activity of assist. prof. Katerina Lazarova fully meets all the requirements of the Law for the occupation of the academic position "associate professor". In connection with the above, I strongly recommend the honorable Scientific Council of IOMT-BAS to make a decision Katerina Lazarova to take the academic position of "associate professor" in professional direction 4.1 "Physical sciences", scientific specialty "Electrical, magnetic and optical properties of condensed matter" at IOMT-BAS.

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(Prof. Sn. Kitova)