



LATVIAN ACADEMY OF SCIENCES ACHIEVEMENTS IN SCIENCE 2020

DIPLOMA OF THE PRESIDENT

I Global restart of the scientific direction of piezoelectric polymers

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Piezoelectric materials react to mechanical input and generate the electricity. Piezoelectric polymers have become promising energy harvesting materials because their piezoelectric figures of merit are comparable to high density piezoelectric ceramic materials. By employing the specially designed experiments, we have revealed, that the studies published so far in the field of piezoelectric polymeric materials may not reflect their true intrinsic piezoelectric effect! The study also shows a clear and simple methodology for measuring intrinsic piezoelectric effects for piezoelectric polymers. The study allows to understand the existing state in the field of soft piezoelectric materials and will allow the identification of true pathway to improve the piezoelectric performance and ensure the development of next-generation polymer piezoelectric generators.

II Applications of permanent magnet systems for aluminum metallurgy

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In metallurgy, obsolete technologies that are used for the stirring and transport of liquid aluminum between stages of aluminum production today are no longer considered efficient. The use of electromagnetic coils, the advantage of which is the creation of non-contact flows in metal, can be mentioned as a modern but energy-intensive technology for metal transport. Motion initiation in a liquid metal can also be performed with large permanent magnets. In this study, an experimental and theoretical study is performed to apply large-scale permanent magnet equipment in the aluminum metallurgical industry. Within the framework of the research, a dipole of NdFeB magnets with a diameter of 40 cm was made for the first time, which can stir liquid aluminum in a non-contact way through a 20-50 cm thick wall. Currently, several different types of prototypes have been produced, which are being tested for industrial applications for pumping and mixing aluminum, as well as for efficient removal of gases dissolved in aluminum in order to obtain a high-quality final material.

III A new method for the photon path length determination in diffuse reflection

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Diffuse reflection (reflection from the sub-surface layers of light scattering media as a result of photon multiple scattering) can be characterized quantitatively if the distribution of photon path length in the scattering medium is known. It depends on the wavelength of irradiation and the distance between the light input and detection points. Such distributions can be modelled



numerically for specific scattering media (e.g. human skin) but so far there was no method of their experimental determination in a wider spectral-spatial range. In the experiments using the author's developed method by means of a "white" picosecond laser and pairs of identical interference filters, as well as an optical fiber contact probe of novel design and an original deconvolution algorithm, data on remitted photon path length in tissue phantoms and in-vivo human skin at 35 different spectral-spatial combinations were obtained for the first time. The results were published in 2020 at a Q-1 journal with impact factor 4.23.

IV New optical and mathematical methods for improving the quality of an image

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The studies address improving the optical quality images with deformable mirrors. In order to improve the optical quality of an image, the optical distortions must be evaluated first. The optical distortions are evaluated using the measurements of light intensity, and such studies get more and more popular in optics, materials science and other fields of science. The optical system used in this kind of studies is simple, and the algorithms used in these studies analyze data which can be acquired with inexpensive imaging cameras resolving a small number of intensity levels. Much more advanced and expensive imaging cameras were required to implement historically first algorithms. The method can be applied in various technologies improving the optical quality of an image, improving the optical quality of an eye and visual perception, biooptics and analysis of the structure of materials. Another advantage of the method is its applicability under low-light conditions.

V An economic and environmentally friendly method for the synthesis of value-added organic compounds

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Development of novel synthetic methods is the requirement for the progression of medicine and other chemistry-related industries. Accordingly, they have to meet the criteria applicable to nowadays standards such as resource-effectiveness and environmental friendliness. The developed methodology allows to synthesize valuable organic compounds using relatively cheap and non-toxic cobalt catalysts. These synthetic methods ensure the acquirement of new, as well as known compounds with useful properties.

VI Development of new methods of biofuel

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Reducing the share of fossil energy resources in transport energy, thus reducing the environmental and climate impact of the whole sector, requires the development of new methods for the conversion of biomass into fuels and the wider use of electric transport. A group of the Institute of Applied Chemistry carried out systematic research in the field of biofuels with the aim of developing biofuel production technologies that do not use raw materials necessary for food productions, or use them with a higher yield of biofuels. Research includes the development of new methods for the production of advanced biodiesel and more targeted catalytic pyrolysis of



lignocellulosic biomass, as well as the development of new catalysts for the conversion of lignocellulosic synthesis gas into fuels at low pressure and temperature.

VII New synthetic methods in purine chemistry and their application in materials science

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Purine derivatives are known to be important therapeutic agents and have recently emerged also in materials science. The development of novel synthetic methods for substitution of purine system provides access to hitherto unknown derivatives that will allow medical chemists and materials scientists to design new types of molecules and their applications. Azido group was used as a regioselectivity switch and novel purine ring substitution reactions were developed. This allowed reversing the traditional purine substitution style and forming C-N and C-S bonds. The use of 1,2,3-triazoles as leaving groups in purine S_NAr reactions has also been discovered and new C-C, C-N, C-O and C-P bond formation reactions were developed. The developed methodology is general and can be applied also for synthetic modifications of quinazolines and other heterocycles used in medicinal chemistry. The new purine derivatives have strong luminescent properties and they have been used to develop new metal ion sensors and organic light emitting diodes.

VIII Complete and innovative presentation of phenomena and personalities of the Latvian theatre art

Tišheizere, E., Rodiņa, I., Jonīte, D. Mellēna-Bartkeviča, L. "Neatkarības laika teātris. Latvijas teātra parādības un personības gadsimtu mijā un 21. gadsimtā". [Theatre in the Time of Independence. Phenomena and personalities of Latvian theatre at the turn of the centuries and in the 21st century.] Rīga: LU LFMI Publishing House, 2020, pp. 560. Institute of Literature, Folklore and Art, University of Latvia.

The collective monograph is dedicated to the most significant phenomena and personalities of Latvian theatre in their interplay and historical context of the period from the 1990ies to present. Based on novel theoretical guidelines and contemporary foreign studies, the monograph investigates personalities, directions, schools, theatres, revealing the ambiguous relationships between the tradition and innovation by analyzing not only art of acting, directing and production but also stage design.

IX More than ten-year science project on commentaries of the Constitution of Latvia has been completed

Commentaries on the Constitution of the Republic of Latvia. Chapter II. The Parliament. Scientific editor LAS Corresponding member R. Balodis. Rīga: Latvijas Vēstnesis, 2020, pp. 720. ISBN 978998484065. University of Latvia, SJSC "Latvijas Vēstnesis".

The completion of the Commentaries on the Constitution of the Republic of Latvia provides access to the scientific comments of the Preamble and each of the 116 articles of the Constitution for a wide range of audiences. The Commentaries present an authoritative auxiliary source of law in the application of the Constitution, which reflect the view of the legal doctrine on the content of



constitutional norms. Commentaries on the Constitution enrich the understanding of the Constitution and render support to the parties applying law in deciding on particular issues of law, both as regards content and methodology. Thus, they are a proof of a certain maturity of Latvian science of constitutional law and its ability to give quality contribution to the strengthening of the principles of constitutionalism in the State of Latvia. The work is unique, since only in this edition one can find not only scientific but also popular scientific information (such as the electoral model of Latvian Parliament, the Parliament commission, Parliamentary inquiries, Parliament Members' responsibility and non-accountability, etc.). Volumes include also articles describing the important constitutional problems. For a better understanding of the Constitution, these include specific theories and documents related to the history of the Constitution, which serve as an assistant to the reader when reading the relevant comments of articles.

X A novel study into the business support system in the border regions of Latvia and Lithuania

Monograph "Possibilities of increasing the competitiveness of the business support system in the border regions of Latvia – Lithuania". Riga: LAS Institute of Economics, 2020, pp. 300. *Authors: Dr.oec. J. Vanags, Dr.paed. N. Linde, LZA Full member B. Rivža, Dr.oec. M. Bezpartochnyi, Dr.oec. V. Riashchenko.*

The establishment of a joint system of entrepreneurship support for border regions of Latvia and Lithuania is an unprecedented event in the history of the existence of the Baltic States. The initiative of the Zemgale planning region fully complies with the strategy for increasing the competitiveness of the Baltic States and the European Union as a whole, aimed at increasing the competitiveness of the business environment, on one side, and increasing the efficiency of the use of resources by state support organisations on the other.

Research into the implementation options for a business support system in Latvia and Lithuania is done by the Latvian Academy of Sciences Institute of Economics within the confines of the Latvian-Lithuanian cooperation programme for the period of 2014-2020. (Interreg V-A Latvia-Lithuania 2014-2020) project No. LLI131 "Business support system creation and accessibility in Zemgale, Kurzeme and North Lithuania/Business Support".