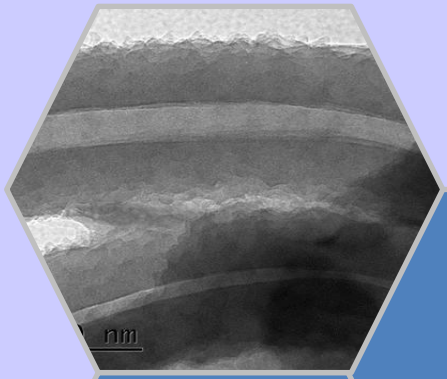
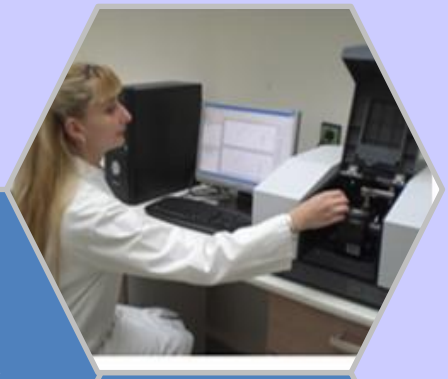
BULGARIAN ACADEMY OF SCIENCES

INSTITUTE OF POLYMERS

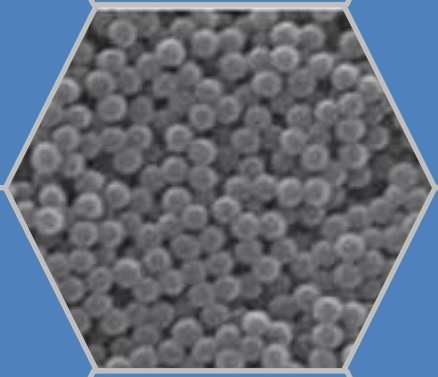
2015





Amphiphilic and Ionogenic Polymers

Structure and Properties of Polymers

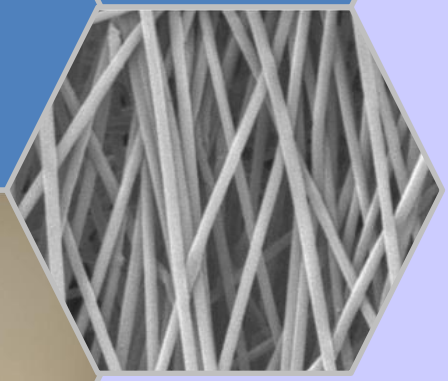


Polymerization Processes

Conjugated Polymers

Phosphorus Containing Monomers and Polymers

Biologically Active Polymers



This booklet aims at informing the academic community, businesses and the general public about IP - BAS research activities in 2015. The booklet presents briefly the scientific scopes of IP-BAS, the most significant achievements in fundamental and applied research, as well as the activities of national and public importance.

We expect the visibility of our activities to augment the possibility of future collaborations with new partners from academia and industry.

The booklet is published with the financial support of the POLINNOVA project - "Strengthening the research capacity and innovation potential of the Institute of Polymers at the Bulgarian Academy of Sciences for further integration into the ERA ", financed by the 7th Framework Programme of the European Union, "Capacities - Research Potential "(GA № 316086).

IP-BAS, 2016

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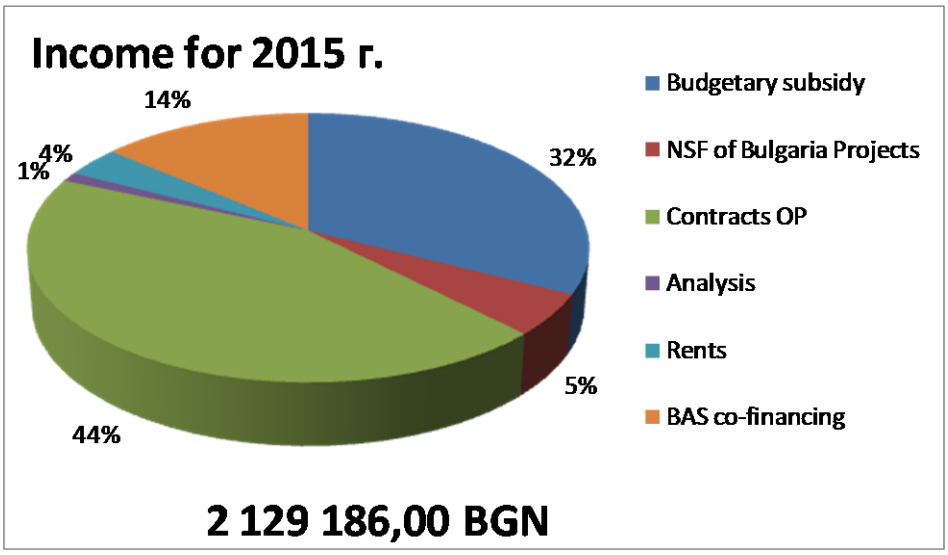
INSTITUTE of POLYMERS
BULGARIAN ACADEMY OF SCIENCES

The Institute for Polymers (IP-BAS) is an autonomous research unit within the thematic area 'Nanosciences, New Materials and Technologies "of the Bulgarian Academy of Sciences. IP-BAS is a leading Bulgarian center in the field of polymer science. The activities of the Institute include fundamental and applied research, consulting and expertise services as well as Ph.D. training in polymers and polymer materials. Ever since its foundation in 1990 the Institute has been pursuing recognition as a center of excellence in the European Research Area.

The mission of the IP-BAS is to carry out high quality research and education/training in the filed of polymers and polymer materials and to transform the accumulated knowledge into new materials, products and services thus meeting requirements of the industry and society.

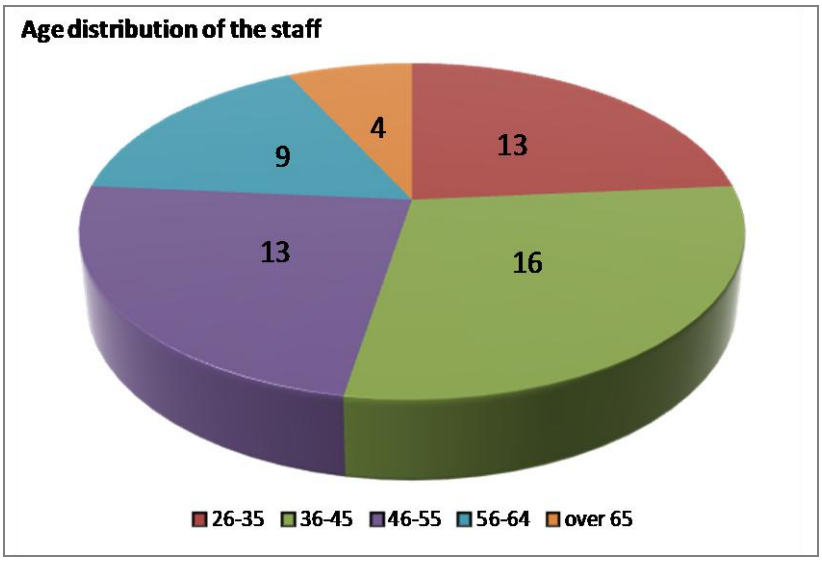


The research at IP-BAS is organized on a project basis and is financed by budget subsidy and grant competition programs of the National Scientific Fund (NSF), other international scientific programs and framework programs of the European Union. That guarantees carrying out research in areas of priority for Bulgaria and Europe, as well as an effective and transparent spending of taxpayers' money. The Institute staff is of 55 full-time employees, including 36 researchers (professors – 3; associate professors – 10; assistant professors – 16; research assistants – 7; specialists with PhD degree - 1); 16 – university graduates and 3-maintaining personnel. In 2015 the Ph. D. students trained at IP-BAS were 13.

The Institute includes six research units, named laboratories:

- Amphiphilic and Ionogenic Polymers (Head: Assoc. Prof. Darinka Hristova, Ph.D.)
- Bioactive Polymers (Head: Prof. Nevenka Manolova, D.Sc.)
- Conjugated Polymers (Head: Assoc. Prof. Vesselin Singerski, Ph.D.)
- Phosphorus Containing Monomers and Polymers (Head: Assoc. Prof. Ivanka Kraicheva, Ph.D.)
- Polymerization Processes (Head: Prof. Stanislav Rangelov, D.Sc.)
- Structure and Properties of Polymers (Head: Prof. Petar Petrov, D.Sc.)

The research laboratories do investigations in certain thematic areas, in accordance with the research priorities of IP-BAS. The activities are coordinated through the annual research plan of the Institute.



PRIORITY RESEARCH FIELDS

In 2015 the research carried out at IP-BAS was in accordance with the mission of the Institute and the research priorities approved in 2014 and set in IP-BAS research plan for the 2014-2016 period. Those are:

1. **New Polymers and Innovative Polymeric (Nano)Materials and Technologies**
2. **Polymer Materials for Biomedical, Pharmaceutical and Biotechnological Applications**
3. **Polymer Materials for Alternative Energy Sources and Polymers from Renewable Unconventional Resources**

The thematic research fields of IP-BAS are compliant with three of the five priority areas of the National Strategy for Scientific Research 2020 (NSSR-2020), namely Priority Area 1: Energy, energy efficiency and transport. Development of green and eco technologies; Priority Area 2: Health, Quality of Life, Biotechnology and Ecological Foods; Priority Area 3: New Materials and Technologies. Noteworthy, a significant part of the research carried out at IP-BAS is of applied character.

In 2015 innovative investigations on the preparation of new polymeric (nano)materials with tailored properties were carried out within Research Topic 1: New Polymers and Innovative Polymeric (Nano)Materials and Technologies. A great part of the papers published in 2015 reported results concerning the preparation of polymeric nanocapsules, micelles, liposomes, micro- and nanostructured hydro- and cryogels and their characterization via modern physico-chemical methods. In 2015 the research on preparation of micro- and nanofaborous materials via electrospinning or in combination with electrospraying continued. These investigations have been carried out within interdisciplinary projects that allow proving of the potential for application of the designed materials on the basis of their size, structure, functionality, "smart" behavior, etc.

An essential part of the scientific production (over 50%) and IP-BAS projects are in the field of Research Topic 2: Polymer Materials for Biomedical, Pharmaceutical and Biotechnological Applications. The studies were focused on the preparation of new drug carriers possessing antibacterial and/or antitumor activity, carriers of DNA and new materials for wounds healing. Their potential applications in medicine and pharmacy have been confirmed by appropriate biological and microbiological tests and assays. During the reporting period the research at IP-BAS was focused on obtaining: micellar polymeric systems for transfer of anti-cancer and/or anti-inflammatory compounds (prednisolone, budesonide, cisplatin, curcumin); polyphosphorous aggregates of the antitumor agent paclitaxel; new nanosized polymer carriers such as DNA delivery systems of genes; stabilized liposome carriers and polymeric hydrogels for drug release; new micro- and nanofibrous polymeric materials with antibacterial activity (without or with incorporated biologically active natural or synthetic substances).

The research performed at IP-BAS regarding Research topic 3: Polymer Materials for Alternative Energy Sources and Polymers of Renewable Unconventional Resources covered obtaining new polymeric materials for fuel cells, solid polymer electrolytes for alkaline electrolysis. Investigations on creating new polymer solar photo elements - design and characterization of polymer organic photovoltaic cells were also implemented. These studies during the reporting period were within 2 projects funded by NSF.

The efforts of IP-BAS staff were also aimed at improving the research infrastructure of the Institute. New equipment for analysis of polymers and polymeric materials worth nearly BGN 2 000 000 was purchased through ongoing projects under FP7 and European Structural Funds (OP "Competitiveness of Bulgarian Economy").

Scientific Results Achieved in 2015

The research at IP-BAS is planned and organized on a project basis. In 2015 the scientist at the Institute worked on **8 project themes** financed by the budgetary subsidy. The activities involved implementation of **1 project** funded by FP7 and of **1 projects** under OP "Human Resources Development", and **1 project** under "Development of the Competitiveness of the Bulgarian Economy" programme, **11 projects** funded by the NSF, and **8 projects** within bilateral agreements with foreign academies of sciences. The research results were published in **38 articles** and **4 book chapters**, issued in 2015. **30** of the publications are in specialized journals with an impact factor(IF), and 60% of them in journals having (IF)> 2.0.

The selected papers published in 2015 are listed bellow according to journals' impact factor:

- E. Haladjova, S. Halacheva, V. Posheva, E. Peycheva, V. Moskova-Doumanova, T. Topouzova-Hristova, J. Doumanov, S. Rangelov, *Comblike Polyethylenimine-Based Polyplexes: Balancing Toxicity, Cell Internalization, and Transfection Efficiency via Polymer Chain Topology*. **Langmuir** 31 (2015)10017-10025. **IF ^{2014} 4.457**

- K. Kalinov, M. Ignatova, N. Manolova, N. Markova, D. Karashanova, I. Rashkov, *Novel antibacterial electrospun materials based on polyelectrolyte complexes of a quaternized chitosan derivative*. **RSC Advances** 5 (2015) 54517-54526. **IF 2014 3.840**
- K. Yoncheva, K. Kamenova, T. Perperieva, V. Hadjimitova, P. Donchev, K. Kaloyanov, S. Konstantinov, M. Kondeva-Burdina, V. Tzankova, P. Petrov, *Cationic triblock copolymer micelles enhance antioxidant activity, intracellular uptake and cytotoxicity of curcumin*. **International Journal of Pharmaceutics** 490 (2015)298-307. **IF 2014 3.650**
- K. Yoncheva, M. Kondeva-Burdina, V. Tzankova, P. Petrov, M. Laouani, S. Halacheva, *Curcumin delivery from poly (acrylic acid-co-methyl methacrylate) hollow microparticles prevents dopamine-induced toxicity in rat brain synaptosomes*. **International Journal of Pharmaceutics** 486 (2015) 259-267. **IF 2014 3.650**
- E. Haladjova, B. Trzebicka, L. Otulakowski, N. Oleszko, W. Wałach, M. Libera, S. Rangelov, A. Dworak, *Hybrid nanoparticles obtained from mixed mesoglobules*. **Polymer** 68 (2015) 65-73. **IF 2014 3.562**
- Jelezova, E. Drakalska, D. Momekova, N. Shalimova, G. Momekov, S. Konstantinov, S. Rangelov, S. Pispas, *Curcumin loaded pH-sensitive hybrid lipid/block copolymer nanosized drug delivery systems.* **European Journal of Pharmaceutical Sciences** 78 (2015) 67-78. **IF 2014 3.350**
- N. Pippa, R. Kalinova, I. Dimitrov, S. Pispas, K. Demetzos, *Insulin/poly(ethylene glycol)-block-poly(L-lysine) complexes: Physicochemical properties and protein encapsulation*. **The Journal of Physical Chemistry B** 119 (2015) 6813-6819. **IF 2014 3.302**
- Z. Todorova, N. Koseva, K. Troev, *Sylilation of Poly(alkylene H-phosphonate)s – Rapid and Efficient Method for Obtaining Poly(alkylene trisilylmethylphosphite)s*. **European Polymer Journal** 62 (2015) 87-96. **IF 2014 3.005**

98 communications (oral and poster) were presented at national and international scientific forums.

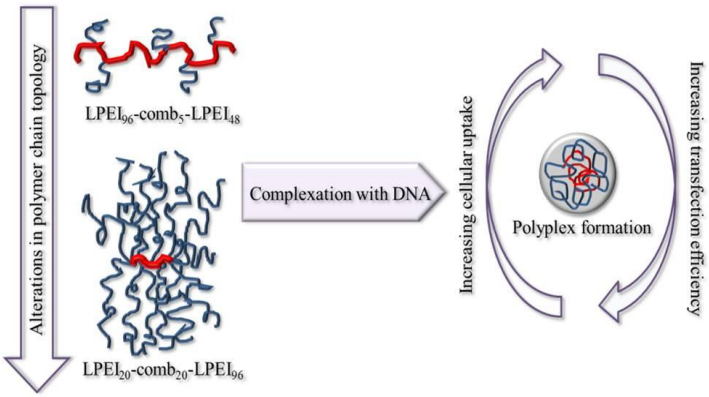
The citations of papers published by IP-BAS scientists in 2015 are 1238. The cited publications are 379; setting the average citation rate at 3.27.

Best Fundamental Research Achievement

Effect of the Topology of Comblike Polyethylenimines upon the Biological Activity of Vector Gene Transfer Systems

Project Leader: Prof. Stanislav Rangelov, D. Sc.

A series of cationic comblike polyethylenimines of different topology that gradually changes from longer main chain/shorter branches/lower grafting density to shorter main chain/longer branches/higher grafting density have been obtained. The polymers are able to react electrostatically with DNA, what results in formation of nanosized particles (polyplexes) of size of 130 – 330 nm and surface potential of -30 – +15 mV depending on the ratio between amino and phosphate groups. Both the polymers and polyplexes are less toxic than the commercial products used. Although the physicochemical properties of the polyplexes are independent from the polymer topology, the cellular internalization and transfection effectiveness differ significantly, e.g., the polyplexes based on polymers with almost linear chain architecture internalize at a greater extent via endocytosis, but fail to overcome the lysosome compartments and are eliminated. On the contrary, the polyplexes based on polyethylenimines of denser structure internalize via a mechanism different form endocytosis and exhibit much higher transfection effectiveness.



Effect of the Topology of Comblike Polyethylenimines upon the Biological Activity of Vector Gene Transfer Systems

The results were published in:

Haladjova, E.; Halacheva, S.; Posheva, V.; Peycheva, E.; Moskova-Doumanova, V.; Topouzova-Hristova, T.; Doumanov, J.; Rangelov, S. Comb-like Polyethyleneimine-based Polyplexes: Balancing Toxicity, Cell Internalization, and Transfection Efficiency via Polymer Chain Topology. *Langmuir* 2015, 31 (36), 10017-10025. *IF^{2014} 4.457*.

Best Applied Research Achievement

Water Soluble Form of Propolis

Joint project of the Institute of Polymers and the Institute of Organic Chemistry with Centre of Phytochemistry -BAS

Team Leaders Prof. Petar Petrov, D.Sc.; Prof. Vasia Bankova, D.Sc., Corr. Member of BAS

Water soluble form of poplar propolis (*Populus nigra L.*) containing all biologically active components extracted by ethanol has been developed. The product is a stable colloidal solution wherein the water-insoluble compounds are entrapped in polymer micelles having a hydrodynamic diameter *ca.* 20 nm. The colloidal aqueous solution is transparent, yellow-brownish in colour and does not precipitate within twelve months. For comparison, without polymer, propolis added in water forms an opaque suspension which precipitates after a couple of days. Propolis concentration in the colloid solution could reach 20 mg/mL. The aqueous colloid solution is in a form ready for oral administration.

The results were included in an application for a utility model filed in the Bulgarian Patent Office:

П. Петров, Хр. Цветанов, П. Мокрева, В. Банкова, Б. Трушева, М. Попова, „Състав на водоразтворима форма на прополис"; Application №/Date: 3103/30.09.2015 г., Applicants: IP-BAS and Institute of Organic Chemistry with Centre of Phytochemistry –BAS.

Digital photograph of a stable colloid aqueous solution of propolis /copolymer (left) and aqueous suspension of propolis (right)/.

In 2015 scientists from IP-BAS received the following awards:

- On June 18, 2015 Assoc. Prof. Nelly Koseva received the Grand Prix for a successful coordinator of international projects at the official ceremony of the Annual Sciences Awards "Pythagoras" for 2015.
- Researchers from the Institute were nominated in two other categories of the Annual Sciences Awards "Pythagoras" 2015: Ass. Prof. Antonia Tontcheva, Ph.D. for the Grand Prix for a Young Scientist and Prof. Nevenka Manolova for the Award for an established scientist in the field of Natural Science and Mathematics.
- Prof. Kolyo Troev, D.Sc., received the Marin Drinov Award of BAS for contributions to research in the field of phosphorus-containing monomers and polymers.
- Ass. Prof. Antonia Tontcheva, Ph.D. won the Professor Ivan Schopov Award of the Union of Chemists in Bulgaria for outstanding young scientist in the field of polymers in 2015.
- Ph.D. student Gyuldjan Yakub won the Aldrich Materials Science Award for Best Poster at the International Conference *"Challenges in Science and Technology of Polymer Materials"*, 19-23 May 2015 Bansko, Bulgaria.
- Ph.D. student Dimitrina Bibikova won the Best Poster award at the *VIth Poster Session Young Scientists in the World of Polymers*, held at IP-BAS, Sofia, Bulgaria.
- Ass. Prof. Emi Haladjova, Ph.D. won the Best Poster Award at the *17th International Workshop on Nanoscience and Nanotechnology, NANO 2015, 27 - 28 November 2015*.
- In 2015 Corresponding Member of BAS Christo Tsvetanov was elected Academician of BAS.

INTERNATIONAL COLLABORATION

The researchers at IP-BAS have been fostering long lasting and fruitful scientific contacts with colleagues from academic institutions and universities in Europe and Asia. The research is carried out in the framework of joint projects at academic and institutional level.

Within contracts and agreements with foreign academies

In 2015, the scientists from IP-BAS participated in 8 projects within agreements with foreign academies: 3 with the Polish Academy of Sciences (Centre of Polymer and Carbon Materials); 1 with Tokyo Science University; 1 with the City of Scientific Research and Technology Applications, Egypt; 1 with the Institute of Macromolecular Chemistry "Petru Poni" Iasi, Romania; 1 with the University of Mons-Hainaut, Belgium; 1 with the Institute of Materials Science – VAST, Vietnam. Five researchers from the Polish, Romanian and Vietnamese partnering organizations were on research stays within the framework of the bilateral cooperations.

Within contracts and agreements with other research organizations

A major part of short-term and long-term research stays in 2015 were covered by the grant of the POLINNOVA project GA № 316086, and 6 short research stays were funded by contract BG051PO001-3.3.06-0017 OP "Human Resources Development".

In 2015, 16 foreign scientists from Belgium, Greece, Romania, Poland and Vietnam visited IP-BAS within the frames of bilateral projects or the POLINNOVA project.

The international collaborations facilitate the mobility and exchange of scientific experience as well as contribute to the increase of the competitiveness and stimulate the innovation activities at IP-BAS (23 of the articles published in 2015, are in co-authorship with scientists from the foreign partners of the Institute).

In 2015 IP-BAS was a member of the following research networks: *Precision Polymer Materials* – a research network of the European Science Foundation; *COPOLYMAT* - between IP-BAS and the Center for Polymer and Carbon Materials, Polish Academy of Sciences, and *European Energy Reseach Alliance (EERA).*

IMPORTANT PROJECTS WITH INTERNATIONAL FUNDING

The implementation the project "Strengthening research capacity and innovative potential of the Institute for Polymers, Bulgarian Academy of Sciences" (POLINNOVA, GAN№ 316 086), funded under the 7FP of the European Union, "Capacities - Research potential" continued in 2015. The Capacities program is aimed at unlocking the full potential of the EU in support of the vanguard initiative, under which research and innovation are key factors for sustainable development, competitiveness and social progress. The total project cost is EUR 2 151 327.

The realization of the project contributed to the sustainable development of the Institute and its active presence in the European Research and Innovation Area as a center for development of advanced polymer materials which find application in vital areas such as medicine and pharmacy, agriculture and food processing, environment protection, alternative energy sources, etc.

An instrument for dynamic-mechanical analysis (DMTA) of polymer materials and combined equipment for investigation of polymers, polymer solutions and colloid systems via static/dynamic and electrophoretic light scattering were purchased within the project.

As mentioned above, a major part of the short-term and long-term research stays in 2015 were covered by the grant of POLINNOVA project. The grant also facilitates the dissemination of the scientific results of IP-BAS via presentations at scientific forums and issuance of advertising materials. One experienced scientist was recruited within the project in 2015.

The international conference "Challenges in Science and Technology of Polymer Materials" was held from 19 to 23 May 2015 in Bansko with the financial support of the POLINNOVA project. This forum was organized by IP-BAS within the activities for dissemination of IP-BAS research results and promotion amongst the global scientific community. The main objective of the conference was to bring together Bulgarian scientists working in the field of polymers and representatives

of leading polymer research groups at a scientific forum for presenting and discussing the achievements and highlighting trends in the thematic areas:

- polymers for pharmacy, medicine and health care;
- polymers in nanoscience and nanotechnology;
- polymers for sustainable development;
- polymeric biomaterials;
- new technologies and methods for synthesis of polymers;
- modern methods for analysis of polymers;
- polymers for energy and optoelectronic devices.

The conference was attended by 53 foreign researchers from 16 European countries, USA and Japan and by 56 scientists from Bulgaria. The forum was opened by Assoc. Prof. Neli Koseva, Director of IP-BAS and POLINNOVA project coordinator. 5 plenary lectures, 7 keynote lectures and 31 oral communications were presented within the six sessions. In two poster sessions 51 posters were presented, mostly of young researchers. Of particular interest were the plenary lectures delivered by world known scientists Prof. Klaus Mullen from the Max Planck Institute for Polymer Research, Mainz, Germany; Prof. Yoshihito Osada from the RIKEN Institute, Japan; Prof. Dirk Grijpma from the University of Groningen, the Netherlands; Prof. Andrew Dove from the Warwick University of Coventry, UK, and Dr. Boris Vratzov, co-founder and CEO of the company NT & D-Nanotechnology and Devices, Aachen, Germany. A prize for "Best Poster" was given from the Aldrich Materials Science (Germany) company. Detailed information can be found at the website of the conference: http://challenges2015.polymer.bas.bg/

PROJECTS WITHIN THE OPERATIONAL PROGRAMMES

In 2015, IP-BAS was realizing a project funded by OP "Human Resources Development".
The project (BG051PO001-3.3.06-0017) - "Development of scientific potential for sustainable career development of young scientists, PhD students and postdocs in priority areas of polymer science " supported PhD students and young scientists from the target group in terms of their research with the purchase of chemicals and supplies, as well as providing financial resources for their research work and for attending scientific forums to present the results achieved. Workshops and lecture courses were organized with the financial support of the project.

OPERATIONAL PROGRAMME "Development of the competitiveness of the Bulgarian economy" 2007-2013 www.opcometitiveness.bg

In 2015, IP-BAS also performed activities related to the project funded by OP "Development of the Competitiveness of the Bulgarian Economy": BG161PO003-1.2.04-0096-S0001 "Support for applied research at the Institute of Polymers to develop new polymeric and composite materials from unconventional resources with applications in environmental, energy saving and health-related technologies". The project aimed at creating a modern pro-innovative infrastructure at IP-BAS through acquiring and upgrading the equipment suitable for applied research in priority areas. The equipment purchased within the projects includes:

- Atom force microscope BRUKER DIMENSION ICON with ScanAsyst®;
- Apparatus for physico-mechanical tests of materials and nanomaterials– INSTRON 3344;
- Potentiostat/Galvanostat;
- Melt flow tester CEAST MF20, INSTRON;
- Minicompounder (mini extruder) Thermo Scientific HAAKE MiniLab II;
- Hydraulic laboratory press for standard samples;
- Automatic Melting / Boiling Point Apparatus;
- Apparatus for thermal gravimetric analysis;
- Automatic contact angle measurement system

TUITION OF SPECIALISTS

In 2015, 13 PhD students were trained in the field of polymer science under the supervision of highly qualified scientists of IP-BAS. Within the Postgraduate School frames at BAS 3 lecture courses for PhD students were delivered. Scientists from IP-BAS are also co-supervisors 2 PhD students outside the Academy. Lectures were delivered to the M.Sc.

students from the Faculty of Physics and the Faculty of Chemistry and Pharmacy at the Sofia University as well. In 2015, 3 students prepared their M.Sc. theses and 1 graduate student was trained at IP-BAS.

In 2015, the project (BG051PO001-3.3.06-0017) - "Development of scientific potential for sustainable career development of young scientists, PhD students and postdocs in priority areas of polymer science" funded by OP "Human Resources Development" facilitated substantially the tuition of specialists.

The aim of the project was to stimulate the development of young scientists, PhD students and post-docs of IP-BAS involved within priority areas of polymer science in accordance with the requirements of building a knowledge based economy, motivation and creation of conditions for manifestation their full potential and realization - a prerequisite for sustainable careers. The project implementation included the following activities: assistance in the preparation of scientific publications and dissertations and support for the research; stimulation of doctoral students from the target group; participation in national and international conferences; specialization in leading European research centers; organizing specialized young scientists workshops in priority scientific areas, provision of laboratory equipment, computer hardware and peripherals; acquiring of information products; management and coordination of the project.

The following Young Scientists Workshops were organized and held:

"*Polymers in medicine and pharmacy*" including 9 lectures with seminars (9 to 28 February 2015);

"New polymeric materials finding applications in environment protection" including seven lectures with seminars (from 11 March to 31 May 2015);

"Development, studies and applications of polymeric nanomaterials" including 8 lectures with seminars (from June 6 to July 17, 2015);

In the course of the workshops scientists from IP-BAS delivered lectures to the young scientists, PhD students and post-docs and discussed the priority research trends in the field of polymers and polymer materials.

The *VIth Poster Session Young Scientists in the World of Polymers* was held within the frames of the POLINNOVA project was dedicated to the 25th anniversary of IP-BAS. The young scientists from IP-BAS presented their research results. A Best Poster award was presented.

Three Ph.D. students defended their theses in 2015:

Emilia Ivanova: *Hybrid copolymers comprising polypeptide blocks. Prepapration, characterization and potential biomedical applications*;

Elena Korina: *Multifunctional hybrid materials based on poly(3-hydroxybutirate) and TiO_2/Fe_3O_4 nanoparticles prepared by electrospinning and electrodispersion.*

Kalin Kalinov: *Preparation and characterization of new nanostructured materials from derivatives of chitosan and synthetic polymers.*

In 2015 there was a competition for an Assistant Professor promotion. Dr. Georgi Grancharov won the competition and his promotion to Assistant Professor was approved by the Scientific Council.

SOCIETAL IMPACT OF THE ACTIVITIES PERFORMED AT IP-BAS

Polymer science being an integral part of the chemical science helps to meet societal needs for new materials, processes and services as well as its everyday needs when addressing global issues such as environmental pollution, efficient use of natural resources, etc. Polymeric materials contribute to the progress in a number of fields such as medicine, pharmacy, environment, transport, ICT, etc. It is expected that the application of nanotechnology in polymer engineering and materials science will lead to creating innovative materials and technologies essential for achieving sustainable economic growth and high quality of life. In 2015 the research carried out at IP-BAS was in accordance with the modern trends of technological development nationally and globally, and in particular concerned the preparation and application of polymers and polymeric materials aimed at improving the quality of life, efficient use of natural resources, environment protection, etc.

Training of students and specialists ensures highly competent professionals and researchers, creating conditions for continuity and development of polymer science in the country. Moreover, the modernization of analytical and specialized equipment allows not only to strengthen the research capacity and innovative potential of the Institute, but also allows improving the contacts of IP with industry, carrying out specific analysis and giving professional advice, participation in research and innovation projects.

On 19th November 2015 an Open Doors Day was held in order to present the Institute's capacity to industry, academia and general public. The modern apparatuses and equipment were demonstrated. The Open Doors Day was met with a

great interest by the public. IP-BAS welcomed representatives of Bulgarian companies such as AT Plast, Ficosota, ELTA'90, FOT and of the academia (institutes of BAS and universities).

In 2015, the expert work of IP-BAS drew media attention and scientists from IP-BAS gave interviews to the two most popular Bulgarian TV channel bTV (Corr. Member of BAS Ilia Rashkov) and Nova TV (Assoc. Prof. Neli Koseva, Ph.D. and Prof. Petar Petrov, D.Sc.). During the Open Doors Day in IP-BAS interviews for theh the newspaper "Az Buki" were given.

IP-BAS relations with other institutions

The traditional intensive collaboration with the following institutions continued in the course of 2015:

- Kozloduy Nuclear Power Plant, Ltd – cooperation within the frames of Memorandum for realization scientific and technical co-project

- Bulgarian Association POLYMERS (BAP) whose members are 37 Bulgarian companies for polymers processing. IP-BAS and BAP signed a contract for working out joint statements and undertaking joint actions for increasing the innovation potential of Bulgarian Polymer science and sustainable development of Bulgarian polymer industry. The Association is a twinning partner in the realization of the POINNOVA project (GA № 316086) funded by 7FP of EU.

National and Operative

In 2015, 12 researchers from IP-BAS provided expert services. Of these, 5 were members of seven expert bodies outside BAS. The number of written materials (expertise, opinions, advice and reviews) without funding is 86 and that of the written material (expertise and reviews) with funding from IP-BAS subsidy or from external sources - 20.

Members of seven expert bodies outside BAS were:

- Specific Programme Committee Configuration "ERC, FET and MSCA" - Assoc. Prof. Neli Koseva, Ph.D. ;
- Subcommittee "Research and Technological Development", OP "Science and Education for Smart Growth" - Assoc. Prof. Neli Koseva, Ph.D.
- Expert Council on Science, Technology and Innovations at the Sofia Municipality - Assoc. Prof. Neli Koseva, Ph.D.
- Science Europe - Assoc. Prof. Olia Stoilova, Ph.D.;
- National Council on Innovations - Assoc. Prof. Olia Stoilova, Ph.D.;
- National Committee of the Polymer Division of IUPAC – Prof. Nevenka Manolova, D.Sc., Prof. Stanislav Rangelov, D.Sc.;
- National Representative of the Polymer Division of IUPAC – Prof. Nevenka Manolova, D.Sc.;
- Standing Science Committee at NSF – Prof. Kolio Troev, D.Sc.

Assoc. Prof. Neli Koseva, Ph.D. sat in two expert groups at the National Evaluation and Accreditation Agency, preparing evaluation reports on Ph.D. studies programmes.

In 2015 IP-BAS IP-BAS scientists prepared:

- reviews of project submitted to the National Science Fund -2, for the Medical University – Plovdiv – 3.

- reviews and opinions for granting academic degrees and titles - for Ph.D. – 3 reviews, 6 opinions; for D.Sc. – 1 opinion; for Associate Professor - 1 review, 1 opinion; for full professorship - 1 review, 1 opinion.

Scientists from IP-BAS are members of the editorial boards of the scientific journals: Clinical Pharmacology and Biopharmaceutics; Phosphorus, Sulfur, Silicon and Related Elements; Journal of Pharmaceutics; Journal of Bioactive and Compatible Polymers: Biomedical Applications; International Journal of Polymeric Materials and Polymeric Biomaterials; Химия и Индустрия; Nanocontainers; Journal of Polymers; The Scientific World Journal: Chemical Engineering; Journal Of The Bulgarian Academy Of Science; Pharmacia; Polymery; Macedonian Journal of Chemistry and Chemical Engineering и International Scholarly Research Notices, Bulgarian Chemical Communications.

At IP-BAS there is a Colloquium chaired by Prof. Petar Petrov, D.Sc. In 2015, researchers gave lectures at 8 Colloquium meetings. In terms of the addressed problems the meetings could be grouped as follows:

Three meetings at which Ph.D. students reported works prepared for publication or already published:

- Lyudmila Todorova – Ph.D. student at IP-BAS
- Gyuldjan Hikmet Yakub - Ph.D. student at IP-BAS
- Boyana Stoyanova Vasileva - Ph.D. student at IP-BAS

One meeting at which a dissertation for a Ph.D. degree was discussed:

- Gyuldjan Hikmet Yakub - full time Ph.D. student at IP-BAS

One meeting at which Assoc. Prof. Violeta Mitova, Ph. D. presented a lecture.

Three meetings at which foreign guests at IP-BAS presented lectures:

- Prof. Stergios Pispas, Theoretical and Physical Chemistry Institute, National Hellenic Research Foundation, Athens, Greece
- Bernhard De Meyer, Polymer Chemistry Research Group, Department of Organic and Macromolecular Chemistry, Ghent University, Belgium
- Prof. Rumjana Tsenkova, Agriculture Faculty, Cobe University, Cobe, Japan.

IP-BAS participates in a consortium of ten Bulgarian research and educational organizations for building infrastructure for production and testing of new materials with applications in industry, bio-medicine and the environment; research, diagnostics, restoration and conservation of metal artifacts "(two modules), which is a part of the National Roadmap of Research Infrastructures, adopted by Resolution 692 of the Council of Ministers of the Republic of Bulgaria on 29th September 2010.

INNOVATIONAL ACTIVITIES

The research carried out at IP-BAS has applied and innovative character. In case of demonstrated interest by industry and provided funding these developments may result into innovation.

In 2015 IP-BAS researchers continued to make efforts for intensification of the innovation activity. Applying the adopted in 2014 Internal Rules for Intellectual Property Management of the Institute of Polymers – BAS and with the financial support the POLINNOVA project in 2015 the following applications were filed:

- *1 application for a Bulgarian patent:* Ch. Penchev, D. Budurova, D. Momekova St. Shenkov, V. Sinigersky, S. Rangelov, Method for preparation and stabilization of concentrated colloidal dispersions of silver nanoparticles in the presence of poly(oxyalkylated) Calixarenes, process for their drying, redispersion and use, patent appl. No. 111935. Priority date: 20th February 2015. Applicant: IP-BAS.

- *1 application for a utility model in Bulgaria*: P. Petrov, Ch. Tsvetanov, P. Mokreva, V. Bankova, B. Trusheva, M. Popova, „Composition of water-soluble form of propolis, utility model appl. No. 3103. Priority date: 30th September 2015. Applicant: IP-BAS and Institute of Organic Chemistry with Centre of Phytochemistry - BAS.

The following applications are undergoing the procedures:

- *1 application for a Bulgarian patent:* N. Koseva, V. Mitova, P. Shestakova, G. Momekov, D. Momekova, K. Troev, Nanosized polyelectrolyte associates with antitumor activity, method for their preparation and use thereof, patent appl. No. 111326, publ. date 30th April 2014. Priority date: 18th October 2012. The application was published in the Official Bulletin of the Patent Office of the Republic of Bulgaria (Bulletin No. 4/30.04.2014). Applicant: IP-BAS.

- *1 application for European patent: I. Sen, N. Koseva, P. Petrov, K. Kostadinov,* Method for neutron detection and neutron detector thereof"; Application No: WO2014BG00024 20140626/26.06.2014 г., Applicant: IP-BAS.

The efforts of IP-BAS to intensify its innovative activities were appraised by the Union of Inventors in Bulgaria (UIB). At the ceremony, which took place on 13th November 2015, IP-BAS received UIB Diploma for an awarded Special Prize - trophy "UIB ITI'2015" from the 6th National Exhibition ITI'2015 – INVENTIONS, TRANSFER, INNOVATION (12 -14 November 2015), part of the days of inventiveness and innovation, which was dedicated to the 25th anniversary of the restoration of the Union of Inventors in Bulgaria.

The following developments that participated the exhibition received a UIB Diploma for an awarded Special Prize - trophy "UIB ITI'2015":

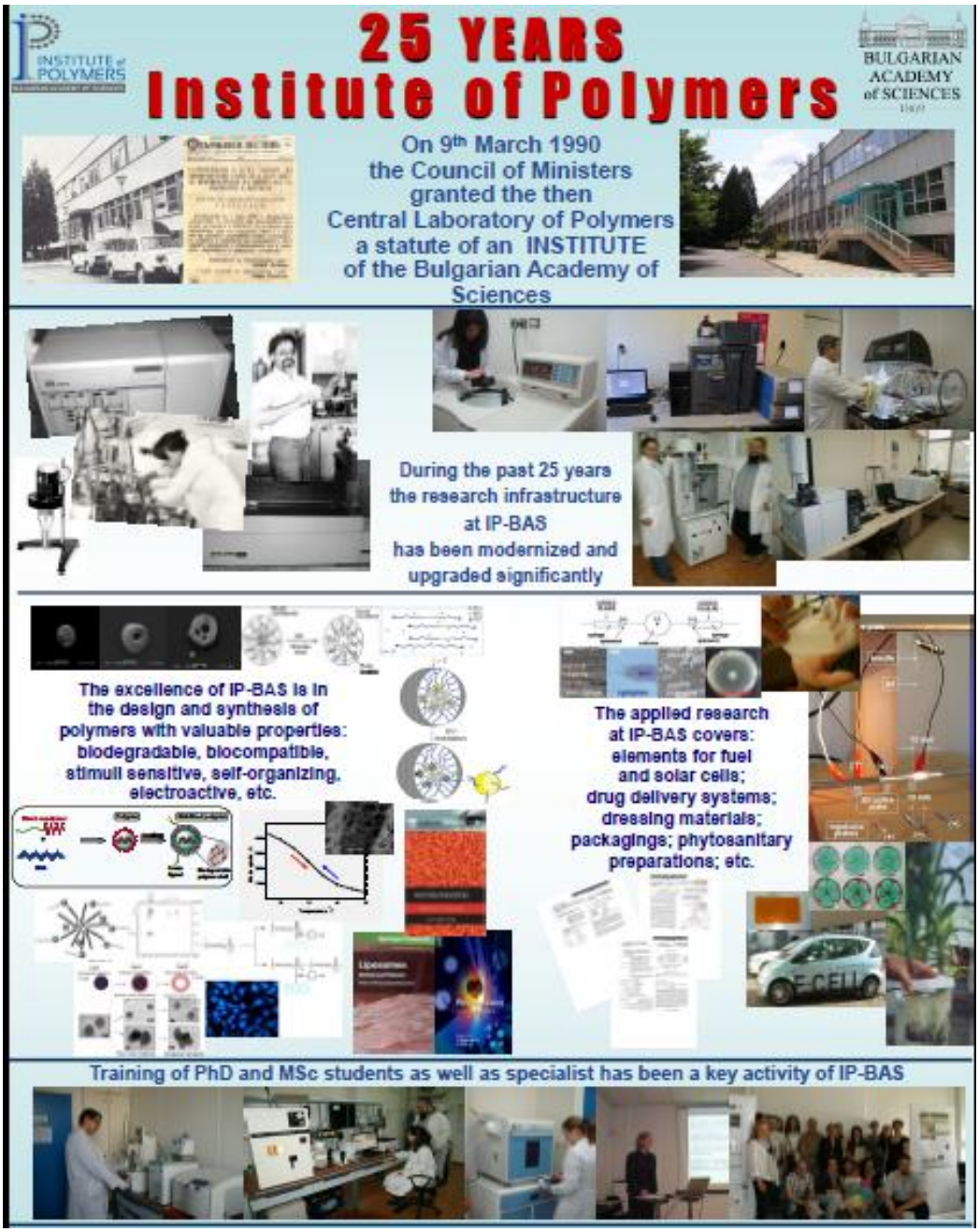
- Composition of water-soluble form of propolis - a joint project with a team led by Prof. Petar Petrov, D.Sc. and V. Bankova, Corr. Member of BAS from Institute of Organic Chemistry with Centre of Phytochemistry -BAS.

- Nanosized polyelectrolyte associates with antitumor effect, method for their preparation and application – the development belongs to a team of scientists from IP-BAS; IOCHFC- BAS and the Faculty of Pharmacy, Medical University – Sofia, lead by Assoc. Prof. Neli Koseva, Ph.D.

- Method for preparation of highly concentrated dispersions of silver nanoparticles stabilized with polyoxilated calixarenes – the development belongs to a team from IP-BAS, the Faculty of Pharmacy, Medical University – Sofia, team leaders – Prof. Stanislav Rangelov, D.Sc.; Assoc. Prof. Hristo Penchev, Ph.D.

Scientists from IP-BAS are co-authors of 10 patents with protected rights.

PUBLICATION AND DISSEMINATION ACTIVITIES



In 2015, IP-BAS celebrated 25 years since the Central Laboratory of Polymers acquired the status of the Institute at the Bulgarian Academy of Sciences. This solemn anniversary was celebrated on March 4, 2015 in the conference hall of IP-BAS. The congratulation address of Acad. Stefan Vodenitcharov, President of BAS was read by Assoc. Prof. Olia Stoilova, 'Nanosciences, new materials and technologies' Scientific Secretary. Greetings on the occasion Institute anniversary were brought by Prof. Nikolay Dishovski, Deputy Rector of UCTM accompanied by a plaque; Prof. Petko Ivanov, Director of the Institute of Organic Chemistry with Phytochemistry Centre; Prof. Vessela Tsakova, Director of the Institute of Physical Chemistry; Prof. Dariya Vladikova, Director of the Institute of Electrochemistry and Energy Systems; Prof. Plamen Stefanov, Director of the Institute of General and Inorganic Chemistry; Prof. Dragomir Yankov, Director of the Institute of

Chemical Engineering, and by Prof. Venko Beshkov, President of the Union of Chemists in Bulgaria. The award of the Union of Chemists in Bulgaria for an outstanding young scientist in the field of polymers for 2015 "Prof. Ivan Shopov“ was presented for the twelfth time. The International conference" Challenges in Science and Technology of Polymer Materials ", Sixth poster session" Young Scientists in the World of Polymers "and the Open Doors Day were devoted to the celebration of 25 years IP-BAS. On March 20, 2015 in the Conference Hall of IP-BAS was celebrated the 80th anniversary of Prof. Ivan Shopov, D.Sc. - Director of the Institute from 1989 to 2003.

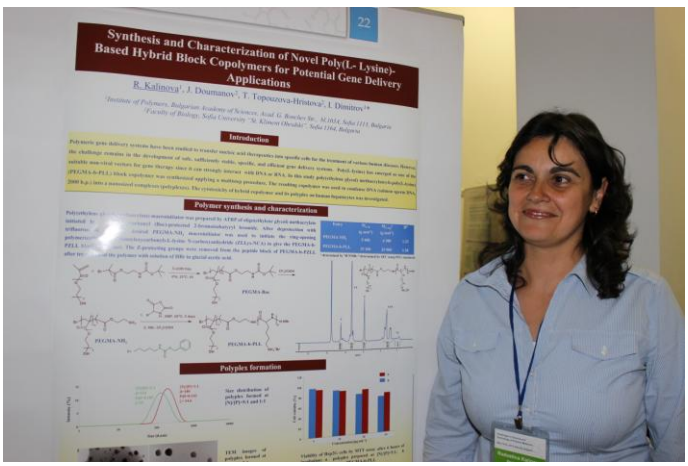
Since 2013 the booklet of IP-BAS has been printed annually. The issue aims at informing the academic staff, business and the general public about the research at the Institute, briefly presents the most significant scientific and applied achievements, the activities of national and public importance.

In 2015 a special leaflet was printed to advertise the modern analytical instrumentation and equipment purchased with the financial support of projects financed by EU funds: POLINNOVA (FP7 GA № 316 086) and GA No BG161PO003-1.2.04-0096-S0001 (OP "Competitiveness of the Bulgarian Economy"). It was distributed to the visitors who came to IP-BAS for the Open Doors Day held on 11th November 2015, and was sent to current and potential partners from academia and industry.

A booklet revealing the results achieved in implementing the project "Development of scientific potential for sustainable career development of young scientists, PhD students and postdocs in priority areas of polymer science" (GA No BG051PO001-3.3.06 – 0017), funded by OP "Human Resources Development", was also issued. The results from the project were presented at an official event on 14th October 2015 in the Conference Hall of IP-BAS.

The web page of IP-BAS (http://polymer.bas.bg) is constantly updated with the latest information and advertisements of the expertise and services that the Institute offers. It aims at extending the contacts with industry. In compliance with the Law for Development of the Academic Staff in Bulgaria information about the procedure for earning academic degrees and titles is duly published. The web page of the project POLINNOVA also informs of the current issues related to the implementation of the project: http://polinnova.polymer.bas.bg/. The Institute is on the electronic catalogue Golden Pages Bulgaria, as well as on the catalogues Compass, Who’s who in European Commerce and Industry, Europa World of Learning, etc.


Choosing the right monomer ... gives straight graphene nanoribbons with atomic precision

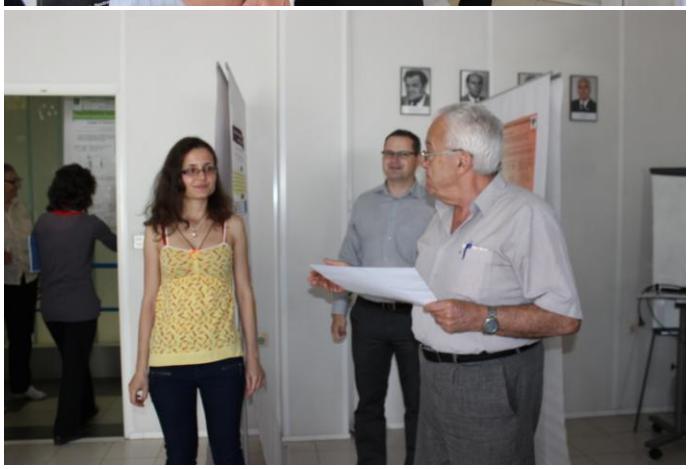

Synthesis and Characterization of Novel Poly(L- Lysine)-Based Hybrid Block Copolymers for Potential Gene Delivery Applications
Introduction
Polymer synthesis and characterization
Polyplex formation


THANK YOU FOR YOUR ATTENTION





A NOVEL APPROACH FOR
SUPER-MACROPOROUS
VIA UV-IRRADIATION
Introduction:
Aim:
Results:

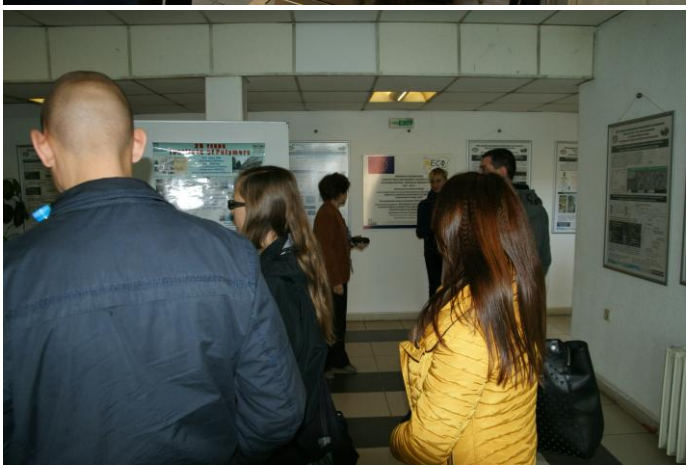


Open Doors Day, 19th November 2015



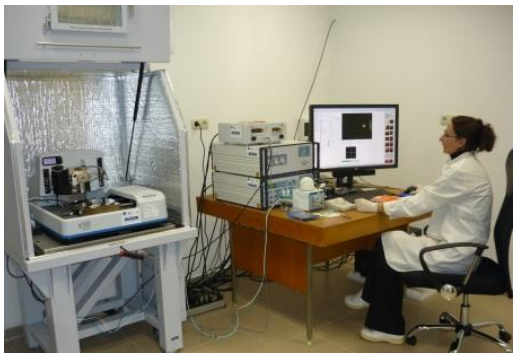




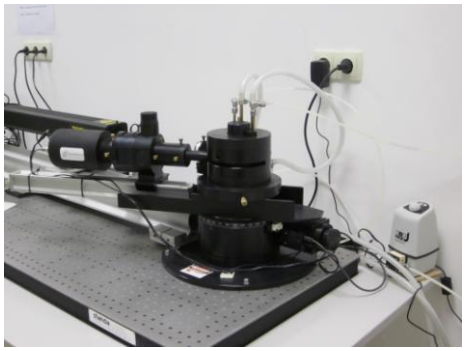



Equipment acquired or brought into exploitation in 2015

Atomic force microscope
BRUKER DIMENSION ICON with ScanAsyst®



Static and dynamic light scattering instrument - Brookhaven BI-200SM



Universal testing system – INSTRON 3344

Melt flow tester CEAST MF20 - INSTRON

Metrohm automated titration system

Tensiometer K100 - KRÜSS

Apparatus for thermal gravimetric analysis with a mass-spectrometer

Mini-compounder Thermo Scientific HAAKE MiniLab II

Hydraulic press for standard samples

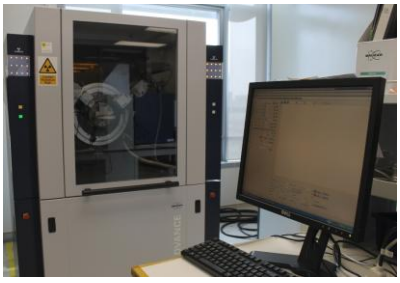
Gas chromatograph AGILENT 7890B

Potentiostat/Galvanostat PGSTAT204FRA32M - AUTOLAB®

Spray drying equipment - Inert Loop B-295, BUCHI

NEXERA XR Ultra High Performance Liquid Chromatograph

X-Ray diffractometer D8 Advance ECO BRUKER AXS



Dynamic Mechanical Analyzer Q800 TA Instruments