

Strategic domains in the R&D activities of the (BIO-NANO-TECH) Institute in the aspect of cooperation between science and business

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Introduction

R&D and implementation of investigation results to practice constitute the Institute's subject of activities the scope of R&D comprises of:

- processing, modification and use of biopolymers
- technology of the manufacture, processing and application of chemical fibres and other polymeric and related materials
- manufacture, processing and quality assessment of pulp and paper- and similar products

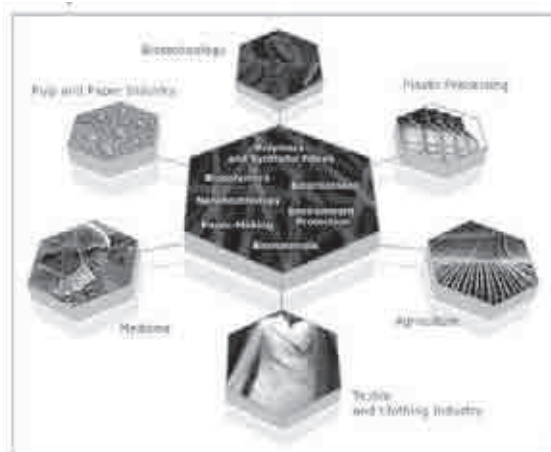


Fig. 1 Domains of research and application [1]

Since many years has the Institute been conducting research tasks important for the economy and society, and participating in numerous international projects. Promotion of innovativeness and quality counts to its mission.

Strategic policy in research is focused on :

1. R&D in a wide range, and reducing to practice of results based on achievements in the BIO-NANO-TECHNO sectors.
2. Development of a modern infrastructure.
3. Intensification of the cooperation with industry.
4. Carry out tasks important for the country's economy and society as well as national defense.
5. Strengthen the Institute' international position.
6. Conduct science-supporting activities: education and training, publication, standardization and association.
7. Marketing and market studies related to commercialization of results.

The Institute's R&D activities

In cooperation with science and industrial units, has the Institute since long time conducted interdisciplinary R&D works in following domains:

Biopolymers – modification, processing and application

The Institute specializes in that field since many years. Scientific works include such polymers as chitin, chitosan, starch, lignin,

alginate and protein (keratin collagen, fibroin) and concern structure and properties of the natural polymers employing chemical physical-chemical and biochemical methods. Preparation of spinning solutions for the forming of fibres, film, nano/micro-fibrous materials and other technical products is another research topic. New forms of biopolymers with a tailored structure and properties are being elaborated for uses in medicine, veterinary, agriculture and technics.

The Institute has enjoyed in that field the cooperation with many foreign companies like Lurgi Zimmer AG, Germany, Celcat Austria, Kimberly Clark Corp. USA, Spolisin, Czech Rep, Domsjo Finland, Buckay, USA in the frame of both European projects and bilateral agreements.

Biomaterials for medicine, agriculture, environment protection and technics.

A number of biomaterial-based products were elaborated in the Institute. Most prominent are: an antithrombotic chitosan preparation, dressings in form of sponge, hydrogel and film of modified chitosan designed for the treatment of difficult healing wounds, a placenta and microcrystalline chitosan-containing dressing "Choriochit" prepared in cooperation with Tissue Bank in Katowice. For an US pharmaceutical company a chitosan-based medical preparation was elaborated which, after the approval by Federal Drug Administration, was commercialized in the States as hemostatic dressing. Prepared was also a resorbable sealing for blood vessel prostheses of synthetic polymers and the modern dressing Tromboguard with hemostatic and wound-healing-accelerating action designed for uniform services (army, police etc).

Investigations in biomaterials are carried out in cooperation with 'TRICOMED SA', a Polish joint stock company and part of the holding Toruńskie Zakłady Materiałów Opatrunkowych (Dressing materials manufacturer), Toruń. Within the activity, a "Clean Room" was installed in the Institute for the preparation of biomaterials according to EU medical directive.

Synthetic polymers and products thereof.

Numerous development works are conducted in the modification of fibre-grade polymers including PES, PA, PP. Investigations are concerned with the improvement of methods to produce and process the polymers as well as with modifications to confer special properties upon fibre and film.

To give just a few examples of the modifications: elastic PP, PES and PA fibre, hydrophilic PA6 fibre, flame-retardant PP and PES fibre, bi-component and capillary fibre, barrier film and functional fibre for textiles with thermal barrier (PCM). Investigations are also made in special polymers such as polymethylpentene (PMP), polyethylenephtalate (PEN), copolyesters and copolyamides applied in the manufacture of fibres and other products.

In synthetic fibres, the Institute has had cooperation with Polish (Comfort Świdnica, Viola-Multitex Mirsk, Poli-Farm Łowicz) and foreign companies (NYLSTAR, Italy, RHODIA, France, ZENON

Canada, PPG Industries, USA, Teijin Twaron, Holland). The Institute is equipped with technology lines to produce fibre from thermoplastic polymers in semi-technical scale (multifilament and stable fibres).

Biodegradable polymers - synthesis, modification and processing.

In virtue of the enormous interest of domestic and foreign companies and recommendations by the European Union concerning the use of environment-friendly technologies and in-nature-biodegradable products, a cycle of research works was launched in the synthesis of biodegradable co polyesters for melt processing. Works were started aimed at the elaboration of an original biodegradable polymer of the aliphatic-aromatic co polyester family. The possibility is also investigated of harnessing the polymer and other commercially available biodegradable polymers to the manufacture of textiles for technical and agricultural applications (including melt-blown and spun-bond techniques).

The research segment is of particular importance for the Institute; it is a subject of 3 projects in the frame of the Program Innovative Economy (key project and two strategic research projects) and research project ordered by Ministry of Science and Higher Education. Based on a proprietary technology, a fully automotive installation will be built in the Institute for the manufacture of a biodegradable polymer.

Bioprocesses in the investigation of the synthesis and modification of polymers and fibres.

Complex investigations are being conducted in the Institute in the use of biotechnology processes for the modification and synthesis of natural polymers. The research comprises amongst other:

- Microbiological synthesis of microbial cellulose modified with oligoaminosaccharides intended for uses in medicine and electro-technics
- Bio-modification of polymers to improve affinity and dissolvability in organic and inorganic solvents
- Bio-indicators for microbiological quality assessment of food products
- Enzymatic catalysis in the degradation of biopolymers to oligomeric fractions
- Composite materials on basis of bacterial cellulose and poly(lactic acid).

The works are consistent with the scientific priorities of the European Technology Platform of the Textile-Clothing Industry contained in the Research Strategy for the T/O industry in the thematic group „Biomaterials, Biotechnology and Environmentally Friendly Textile Processing”.

Nanotechnology in the modification and forming of fibrous materials.

The domain in the Institute has been widened in the last years rather quickly with focus on medicine, tissue engineering and filtration. Many research works are under way aimed at the preparation of nanofibres by electrospinning from renewable resources like PLA, chitosan, starch. Aside of electrospinning, attempts have been made to prepare nano- and microfibers by melt spinning.

Another activity is in the modification of synthetic polymers with nanoparticles to prepare specialty fibres.

New pulp and paper techniques and technologies

The Institute conducts R&D works in the manufacture of fibrous pulp (cellulose, high efficiency, recycle and other) paper and paperboard, special materials (filtration, insulation, hygiene, sealing). Offered are research services and testing in following fields: improvement of paper recycling, environment protection (monitoring, emissions-and waste water treatment), quality assessment of paper raw materials, paper, paperboard, packaging and various paper products.

Good cooperation is maintained in the domain with numerous

renown companies including: . International Paper, Kwidzyn Ltd., Stora Enso Poland SA, Ostrołęka, Mondi Świecie SA, Saturn Management Ltd, Warszawa, Packprofil Ltd., Kolonowskie, Kemira Cell Ltd., Ostrołęka, Polpak-Papier Ltd., Grudziądz, Convert Paper Ltd, Gostyń, DS Smith Polska, Kielce, EKOPAK-JATNE S.A., Celestynów, EKO-PALETA Elwira Łaszcz, Goleniów, Fabryka Papieru „Malta-Decor” SA, Poznań, Fabryka Papieru i Tektury BESKIDY SA, Smurfit Kappa Polska Ltd., Pruszcz Gdański, Sonoco Poland - Packaging Services Ltd, Łódź

Technologies for environment protection in the pulp and paper industry

In the manufacture of chemical pulp unavoidable are emissions of odorous and toxic gases like hydrogen sulfide, mercaptans, methyl sulfides. Pulp and paper processes are energy-intensive generating a lot of energy-related emissions like dust, sulfur-and nitrogen oxides.

Presently, the Institute monitors the emissions at Polish pulp producers and examines the efficiency of emission-absorbing equipment. A close cooperation exists in the field with three biggest pulp and paper makers in Poland International Papier, Kwidzyn, Mondi Packaging Paper, Świecie and Stora Enso Poland.

Insufficiently purified waste water poses an even more serious threat to the environment waters. Durable, resistant to biological degradation substances, primarily lignin compounds, may appear in the sewage. The Institute strives to render the burden harmless. Cooperation in the field is established with Stora Enso Poland and Packprofil, Kolonowskie.



Fig. 2. The Institute's research infrastructure

Strategic actions of the Institute

Many of the Institute's R&D domains are consistent with the strategic sectors of the National Program of Scientific and Development Works (Resolution No 164/2011 of the Cabinet) Direction 4. **Modern material technologies** in the range of multidisciplinary and transdisciplinary research aimed at the strategy goals of Poland's well balanced development primarily with[3]:

- Programmes stimulating the increase of innovativeness, entrepreneurship and competitiveness of Polish economy
- Actions to support research domains in which Poland represents a strong international position
- Programmes that are in line with research priorities of the European Union

- Research domains that pave way to the world's civilization and economy development
- Investigation with the potential of implementing research results to practice
The Institute's research thematic is also reflected in:
- Technology scenarios of the monograph titled Foresight of industrial technology InSight 2020 prepared for the Ministry of Economy in such key sectors as **industrial technology and nanotechnology** [4]
- Communique of the Commission to the European Parliament, Counsel, European Economy and Society Committee and Regional Committee ("European strategy in key technologies supporting the strive toward increase of jobs) in the development of **Key Enabling Technologies (KET)** such as **Nanotechnologies, advanced materials, industrial biotechnology, advanced manufacturing technologies described as KET**[5]

In conformity with the National Program, the Institute conducts and will develop interdisciplinary research which is the most effective source of new products and materials with new or improved properties and new utility contributing to safety and standard of life. The elaborated techniques and technologies reduced to practice may add to the improvement of the national industry competitiveness.

In that range an important role in the Institute play nanotechnologies by which new materials are generated with a programmed structure and entirely new properties and application.

It is envisaged that the research results will bear fruit in the preparation of new effective technologies for the manufacture of functional composite materials and polymeric materials with unique properties and uses in many fields of life and economy and will contribute to a consistent development.

The development of advanced techniques in material engineering will permit a controlled tailoring of the material properties and the preparation of energy-effective and environment-friendly technologies. The here mentioned few research lines in the Institute's activities comprising new materials and technologies shall make a solid base for modern implementations. R&D activities should be focused on the attaining of safe- to- environment and health, biodegradable and biocompatible polymeric materials suitable to uses in food and pharmaceutical industry, as well as in environment protection. A desired use is in technologies for the cleaning of ecosystems and cultivation of ecological plants. An important role to play is for the fibrous and ligno-cellulosic materials.

Be the motto : *Let's try to use all treasures that nature's hides to create what's beneficial to humans, safe to environment and useful to technique.* [6]

The institute' innovation policy—models of cooperation in science, Innovation in technology, integration activity, development of new research domains and commercializing of results are supreme goals in the Institute' scientific policy. The new planned development areas comprise:

- New polymeric materials with barrier properties to improve safety and comfort in use
- New raw materials for the production of functional, smart textile and paper products
- Composite textile materials for human health and safety
- Biomimetic polymeric materials
- Functional products prepared from natural raw materials including waste.

Mechanisms of trilateral cooperation between industrial institutes, Polish Academy of Sciences and universities that proved effective hitherto are to be continued. Such models warrants complexity of the investigations by combining basic and applied sciences with the ultimate goal of ready technologies offered to industry. Experience gained so far indicates the need to involve industrial partners into the

cooperation model. Readiness of companies and institutes to joint innovation actions as soon as in the phase of conceptual works shall be the driving force of modern technologies and will contribute to the development of economy and to the improving of the business – science contacts.

The Institute's R&D works will be oriented toward a steady enhancing its role in the research environment, heightening of the innovativeness of offered scientific services and , above all, improving the success factor concerning implementation of technologies [7].

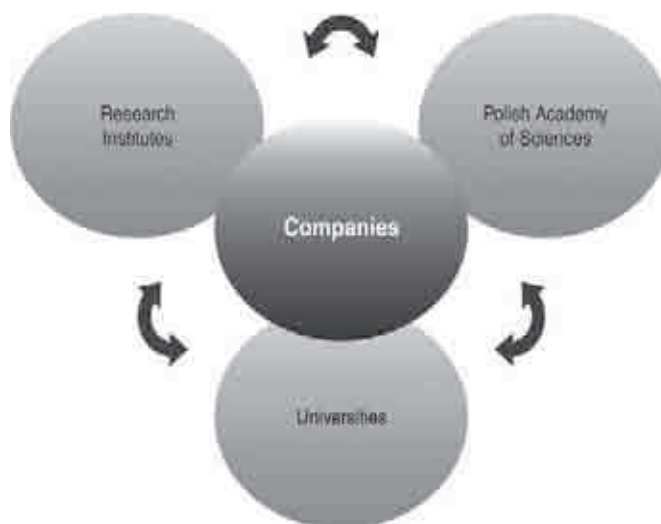


Fig. 3. Model of cooperation in science [7]

The establishing of a specialized BIO-POL-TECH in the Institute brings the chance to widen R&D in biopolymeric materials designed for many industry branches in Poland and to improve implementation of results. Main goal is to be attained by a complex support given to the innovative R&D initiatives of the companies via necessary investment as actions that contribute to the enhancing of competitiveness on the European Common Market and international markets. Detailed goals may also be achieved concerning cooperation between institutes and companies notably by:

- Enhancing the companies innovativeness by implementing of advanced testing and investigation methods that will allow (a) the assessment of raw materials , half products and polymeric products made in Poland and abroad, (b) modification of the products utility properties, (c) processing with application of advanced technology methods, and (d) conducting highly innovative R&D works for example in unique polymeric materials , nano- and biomaterials biocomposites
- Improving the competitiveness of Polish science thanks to providing the possibility of conducting innovative R&D and implementation works with the final result of products and technologies competitive in global scale
- Enhancing the role of science in economy development by adopting a complex scheme of services rendered by the Institute
- Increasing the amount of innovative biopolymeric products, developed in Poland, on the international market
- Creating permanent and attractive jobs especially for young scientists .

What concerns the enhancement of cooperation with industry, the Institute in its strategic planning intends to strive toward the creation of a **scientific-industrial hub** grouping scientific units and representatives of the industrial sector. To attain success, efforts are needed to integrate science and industry circles , define strategic lines for the development of new technologies and research services as well as to determine a common marketing policy.

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Translation into English by the Author

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Antoni NIEKRASZEWICZ - Representative Director in the Institute of Biopolymers and Chemical Fibres in Łódź, graduated from Łódź University of Technology (1973) and in 1982 he defended his doctoral thesis at Faculty of Material Technologies and Textil Design. He specializes in: fibres technology , procesing of bio-polymers and their application in medicine, agriculture and technology. His research focuses on modification of bio-polymers , fibres, bioactive fibres, special medical dressing. He is the author of 105 articles in scientific journals, 22 international patents application, 12 international patents, 31 domestic patents application and 19 patents, 150 conference presentation as well as he was awarded over 50 grants for research projects.

He has received 25 distinguished awards for his scientific activities. He is the creator and member of the Board of the Polish Chitin Society, (between 1993 and 2009 successively - cashier, secretary and vice-president).

Discovery Chemistry Congress 19–20 March 2013 Munich, Germany, Europe

Previous problems with drug discovery led to considerable investment, by the pharmaceutical industry, in combinatorial and discovery chemistry. This conference will integrate the latest structural chemistry with innovative discovery-driven technologies. Taking place in Munich for the second year running, speakers will concentrate on the most important aspects of discovery stages for effective drug design and refinement.

In the current economic climate there is increasing global competitiveness and financial pressure, therefore, this conference aims to explore the options available to maximise the success of drug discovery and development. Speakers have collaborated to provide four accessible tracks:

- Fragment-based Lead Discovery
- Targeting Protein-protein Interactions
- Formulation and Solubility
- Chemical Biology

The tracks offered work synergistically to overcome the challenges of drug delivery in a completely new way. Select Biosciences hope to help delegates convert this expensive, challenging and inefficient process into a more accessible and affordable one.

Keynote Speakers:

- Roderic Hubbard, Professor, University of York
- Helena Danielson, Professor, Uppsala University
- Mark Bradley, Professor/Principal Investigator, University of Edinburgh
- Jennifer Laurence, Associate Professor, University of Kansas
- Sven Stegemann, Director, Pfizer

Web site: <http://selectbiosciences.com>