Tradition of innovation

Lodz University of Technology

70 YEARS OF TUL

NURTURING POTENTIAL

Prof. Stanisław Bielecki, rector of the Łódź University of Technology, talks to Danuta K. Gruszczyńska.

The Łódź University of Technology has turned 70. That's quite a milestone...

This anniversary year is a good time to reflect on the past and think about what lies ahead, how we can live up to new challenges and what we can do for future generations.

Our university has an interesting history. When the textile industry boomed in the second half of the 19th century, Łódź transformed from a village into the second most populous city in Poland. Then the powerful factory owners, who needed qualified staff with technical skills, supported efforts to establish an institute of technology in Łódź. Land had already been assigned for construction and the future institute even had a teaching staff ready, but in the end the project was never approved by Russia's Czar Alexander II [who ruled that part of Poland at the time]. Poland regained its independence in 1918, but Łódź did not get a university of technology of its own. The city had to wait until after World War II, when a decree founding the Łódź University of Technology was signed May 24, 1945. In a way, history has now turned full circle. The university was established on a site formerly owned by textile empires and today, our campus is home to renovated 19th-century villas and factory buildings that we saved from devastation. You could say we have repaid our obligation to the industrial barons of the 19th century for their efforts to open a university of technology in Łódź.

The University of Technology grew rapidly. It started with only three faculties, less than 1,000 students and 100 teaching staff. Today, we have nine faculties, around 20,000 students and 1,400 teaching staff and researchers. We are one of the best universities of technology in Poland.

We are the only university in Poland to have been awarded

the European ECTS Label and Diploma Supplement Label certificates. We were pioneers in Poland in areas such as providing courses taught in foreign languages and the commercialization of research results.

What are your plans for the future?

Universities always need to develop, even those with traditions dating back centuries. That's why we have been considering new forms of education, new research, majors and multidisciplinary projects.

People who know little about Łódź tend to think of the Łódź University of Technology as one focused entirely on the textile industry [for which the city is famous], but that is a major mistake. This is not to say that the textile industry in Łódź collapsed completely after communism fell [in 1989]. All that has changed is the volume of production and the technological complexity of products. A new and different textile industry is emerging, catering to new branches of the economy and society.

We have a lot of achievements under our belt in other areas as well. For example, the Łódź University of Technology used to be the only university or college in Poland to deal with the paper-making industry. We had Poland's only major in cellulose and paper technology.

If it wasn't for the Łódź University of Technology, Poland would not have majors in brewing and the sugar industry. There would be no spirits industry if it weren't for specialists and technology originating from our university. I'm not sure if Belvedere, one of the world's best and most expensive vodka brands, would exist if it were not for experts from the Łódź University of Technology.

How are courses at the university set up? What teaching methods do you use?

We have introduced a teaching style where rather than being passive recipients, students actively acquire professional skills. We specialize in certain majors. We were the first university to introduce industrial biotechnology. We have an International Faculty of Engineering. We already have many groups of students being taught using new methods. We have pioneered methods such as Project Based Learning and Design Thinking in Poland. We have launched a new teaching method called Short Individual Studies. Our strong points also include lifelong learning, and we have a junior high and high school linked to the university. There's also a Children's University and a University of the Third Age.

At one point, we realized that graduates from our high school who came to study at the university often failed to make the most of their potential in their freshman year. These are very talented young people with a passion; most of them speak two foreign languages, and they are well informed. We now provide the most gifted of them with an accelerated learning program that spans six years of studies and research, even allowing these students to earn a doctoral degree. We want to turn our university into a welcoming environment for young and ambitious people where they can fulfill themselves and make their dreams come true.

Does the Łódź Solar Team fall in this category? I've been told by students in the team that they are now busy preparing for the World Solar Challenge—a race for solar-powered cars over thousands of kilometers through the Australian Outback—so studying can wait.

They have the university's full approval and support in this undertaking. I'm not a fan of students being too relaxed in terms of their work, but I know that in this case, getting in the way of a super interesting idea that the students came up with themselves would contradict the university's mission. We aim to be an innovative university, which is why we are introducing research-based learning, especially for students working on their master's-level degrees. Students are required to do a lot of the work on their own. They need to pursue several different fields of research and tackle many diverse problems. In fact, here is where academic careers begin for most of them.

What do you do to encourage potential students to study in Łódź rather than in Cracow or Warsaw?

We conduct unique research, we are setting up new majors, and we are trying to offer something new to young people so as to give them good prospects of finding a job after graduation. I know that young people take into account the big picture before they decide where they want to study, and I can tell you that our university has something absolutely unique to offer. Together with other universities in Łódź, we are building a huge sports center with an Olympic-size swimming pool, a regular training pool, a multi-purpose sports arena and an indoor climbing wall. This is a project of tremendous importance to the university as well as the city and the entire Łódź region.

The Łódź University of Technology campus is a "green" one where heat and electricity are used in an environmentally-friendly manner, largely thanks to our students. Young people are keen to act and you only need to show them something interesting to do and then take a step back and let them do it.

You are vice-president of the Conference of Rectors of Academic Schools in Poland (KRASP), an organization established to represent the interests of the academic community and develop strategies for university-level education in Poland.

I have been involved in the Conference for many years. This has allowed me to gain a broader perspective on university-

"We conduct unique research, we are setting up new majors, and we are trying to offer something new to young people so as to give them good prospects of finding a job after graduation. I know that young people take into account the big picture before they decide where they want to study, and I can tell you that our university has something absolutely unique to offer."

level education in Poland as a whole, including on relations between colleges and the government and parliament. It has also allowed me to gain a broad perspective on the international status of Polish education, especially its standing in the EU. When it comes to research and education, Poland has traditionally worked with Europe, North America and Japan, but now there are also countries such as China, Taiwan, South Korea, Mexico, Brazil and South Africa. These are completely new challenges, if only because of cultural differences. This is a very important aspect of Polish university-level education now that Polish universities are faced with negative demographic trends, the unprecedented mobility of young Poles and the globalization of research and research funding.

The Łódź University of Technology takes part in student and researcher exchange programs. As a result of agreements with other universities, several dozen of our postdoctoral students are working at the best universities in Europe. Some of our teachers spent several years on internships abroad and now they teach their subjects in foreign languages. We also bring in teachers from other countries. In May, we will award an honorary doctorate to Prof. Arieh Warshel, the winner of the 2013 Nobel Prize in Chemistry.

The Łódź University of Technology also works on international projects...

We hold a number of enormously popular international symposiums. The projects we carried out and completed in 2007-2013 were worth a total of around zl.500 million. We are one of three centers in Poland to have made it to the second stage of the "Teaming" initiative, under which new centers of excellence will be established. The initiative is part of Horizon 2020, the biggest EU research and innovation program. The academic community in Łódź, together with two Max Planck institutes, has just been granted 500,000 euros to draw up a business plan for the construction of a Research Center of Excellence specializing in nanomaterials. The new facility will meet global standards and employ an international team of researchers. It will help the Łódź region develop by giving science a bigger role. Our university is also a shareholder in and acts as an advisory body to the BioNanoPark in Łódź.

You are the only Polish university in the European Consortium of Innovative Universities.

We try to be as innovative as possible in everything we do. We aim to educate creative people. We are members of many industrial clusters that we have helped establish. Recently, we founded the Polish Technology Platform for the Bio-economy. This holds huge potential. I believe it can become what the textile industry used to be for Łódź.

The medals we have won at international invention exhibitions demonstrate that the world at large acknowledges the contribution of our university in this field.

What about collaboration with the business sector?

We organize extra classes in enterprise, start-up companies and spin-offs. We strongly support our students in their aspirations to launch businesses. The university is engaged in many international projects, and, for example, we were involved in the recent opening of an Airbus Helicopters Poland engineering design office.

Engineers from the Łódź University of Technology helped build the world's fastest helicopter. We share our laboratories and programs with companies such as Citroen and Peugeot.

You might be a university of technology, but you don't neglect the arts...

We do have young people with artistic talent. Generations of students have sung in our choir, which has been going for 46 years, and listened to our Radio Żak station, which has been on air for 56 years.

For 10 years, the university has had its own orchestra. The Łódź University of Technology's Academic Choir is a renowned ensemble that, for example, accompanies international stars during the famous Night of the Proms concerts held at the Atlas Arena in Łódź.

Our university has several art galleries and we have for years held music evenings and meetings with prominent figures in the arts. Last but not least, there are various student clubs offering something for everyone.

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NEAR-PERFECT GRAPHENE

A team of researchers led by Prof. Piotr Kula from the Łódź University of Technology has developed a method for producing large flakes of graphene with mechanical and electrical properties similar to those of single-crystal graphene.

Prof. Piotr Kula and his generator for the synthesis of large-sized HSMG graphene

Graphene is an allotropic form of carbon with a two-dimensional structure. Thanks to its unique physical and chemical properties, this material may revolutionize many technologies in the near future. The main features of graphene are its high thermal and electrical conductivity, which is likely to revolutionize electronics. The material's high relative strength can also help produce a breakthrough in all industries that require lightweight structural materials, for example in aviation. And the unique sorption and filtration capabilities of graphene (selective permeability of molecules) could lead to new solutions for storing energy and cleaning liquids and gases. With these attributes, graphene could also contribute to the development of highly sensitive sensors.

The 2010 Nobel Prize in Physics went to researchers who separated a layer of graphene from graphite and examined its properties. Since then, intensive work has been in progress on the practical application of graphene. The greatest barrier at the moment to the widespread use of this material is the difficult industrial production of large graphene flakes with properties close to those obtained in laboratory conditions. Single-crystal layers free from crystalline-structure defects exhibit such properties.

At present there are many methods of producing graphene larger than one square meter in size, but this material is far from perfect. Structural defects form during the synthesis of graphene and largely depend on the method of fabrication.

The method developed by Prof. Kula and his team involves the synthesis of graphene from the gas phase on a liquid metal substrate. During this high-temperature process, carbon is supplied to the composite substrate from a mixture of hydrocarbons and hydrogen in precisely specified proportions. As a result of thermal decomposition, a crystalline layer of carbon consisting of only single carbons—in other words graphene—forms on the surface of the liquid metallic phase. This process has a huge advantage over methods of obtaining graphene based on solid substrates because it yields defect-free structures forming on a perfectly smooth liquid surface. During the process of forming graphene on solid substrates, a defect-free surface cannot emerge because the substrate is uneven and defective. The formation of large flakes of graphene on a liquid-phase surface has the additional advantage of enabling the self-organization of graphene grains formed. This results from the possibility of rotating graphene flakes on the liquid phase prior to the formation of a continuous layer. Therefore the resulting structure has a structure similar to that of single-crystal (ideal) graphene.

Research conducted at the Łódź University of Technology has shown that graphene flakes produced with this method have much better mechanical properties than polycrystalline graphene produced with other methods, and therefore this type of graphene is known in international nomenclature as High Strength Metallurgical Graphene (HSMG). In addition to its superior mechanical properties, this type of graphene has physical and chemical properties similar to those of single-crystal graphene.

The Łódź University of Technology, in collaboration with the Seco Warwick company, has designed and created a special generator for the synthesis of large-sized graphene on a liquid metallic-phase substrate. This device enables industrial-scale production of graphene sized 120 x 240 mm. Ultimately, the generator will make it possible to continuously produce graphene on bimetallic composite tapes with a width of 1,500 mm.

THE WORLD'S FASTEST HELICOPTER

The Łódź University of Technology's Institute of Turbomachinery has helped produce the world's fastest helicopter, the X3.

Above: Key X3 project team members: Damian Obidowski, D.Sc.; Maciej Karczewski, D.Sc.; Krzysztof Zobczak, D.Sc.; Prof. Krzysztof Jóźwik

Left: The new helicopter in flight (picture courtesy of Airbus Helicopters)

Aiming to build a flying prototype of the new machine, global aircraft corporation Airbus Helicopters teamed up with the Institute of Turbomachinery in 2008. Aerodynamics is a field of research in which the institute, which has worked with Airbus Helicopters for almost 10 years, has made a name for itself in Europe.

The new helicopter has two short wings on either side of the fuselage with a propeller mounted at the end of each wing. The two extra propellers allow the helicopter to attain high speeds while also allowing it to perform standard maneuvers such as hovering, vertical ascent and descent, and forward flight at low and very low speeds. The performance and capabilities expected of the new machine would be unattainable with standard helicopter and propeller design methods.

The Institute of Turbomachinery was tasked with performing calculations concerning the design of the side propellers, the inlet channel system for the helicopter's engines and the fuselage. The high cruising speed of the new helicopter could hinder the intake of air by the engines. The stream of air supplied into gas turbines has to meet strict criteria and in order to make sure the X3 engines function properly, a lot of work had to be done to optimize the geometry of inlet channels supplying air to the engines.

The shape of the inlet channel system has a direct impact on the geometry of the fuselage. Following stress calculations under different flight conditions, the designers were finally able to build the X3 fuselage. The prototype underwent tests in 2013, reaching a top speed of 472 kilometers per hour during horizontal flight and 483 kph during a shallow dive, setting a world record for a helicopter.

This spectacular success was largely made possible by simulations performed at the Institute of Turbomachinery and by computational methods that the institute devised. The prototype hybrid helicopter opens a new chapter in helicopter design.

In addition to research results that were put to the test in the working prototype, the X3 project has enabled the Institute of Turbomachinery to hire new staff and build good relations with an important industrial partner. Encouraged by its collaboration with the Łódź University of Technology, Airbus Helicopters has opened its first Polish engineering design office in Łódź. This is the company's fourth such office in Europe.

Krzysztof Jóźwik
Institute of Turbomachinery

WOUND DRESSINGS PRODUCED BY BACTERIA

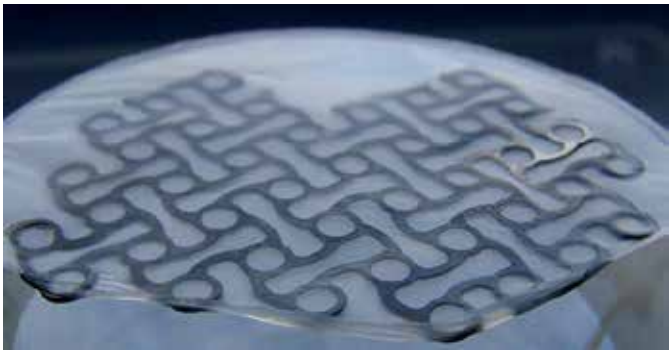
Researchers from the Łódź University of Technology's Institute of Technical Biochemistry have developed a method of producing bacterial nanocellulose for use in dressings that make wounds heal faster.

A research team comprising Prof. Stanisław Bielecki, Alina Krystynowicz, Ph.D., Marek Kołodziejczyk, Ph.D., Teresa Pankiewicz and Jolanta Płoszyńska have isolated a bacterial strain capable of secreting cellulose, the basic structural component of the walls of plant cells. Cellulose fibers produced by bacteria are much thinner than those found in plants, with a thickness measured in nanometers, hence the name of the new material: nanocellulose. In order to highlight the biological origin of nanocellulose, the material is referred to as bacterial nanocellulose or bionanocellulose.

Dressings made of bacterial nanocellulose accelerate the healing of so-called trophic lesions such as diabetes sores, bedsores and ulcers, as well as burn wounds, including extensive second- and third-degree burns. Nanocellulose is 98 percent water and, used as a dressing, a nanocellulose sheet provides a layer that protects the skin against secondary infections. It also eases pain and prevents the loss of bodily fluids. Nanocellulose dressings can be manufactured in various sizes, including very large sheets. Durable and elastic, they can be formed into different shapes. For example, a nanocellulose dressing can be made to follow the contours of a patient's face.

The technology to obtain bacterial nanocellulose is environmentally friendly. The material is free of any toxic compounds and it is also biocompatible, that is, accepted by living organisms. It triggers no allergic reactions or immune responses, and, as an extra benefit, the water locked between bionanocellulose fibrils can be replaced with a drug. All these properties were confirmed during clinical trials conducted at a burn treatment center in Siemianowice Âlàskie, southern Poland. The trials also showed that the moisture under the dressings made wounds heal 40 percent faster than when treated with traditional dressings. Nanocellulose speeds up skin regeneration and scars left after injuries are smaller. Wrapping a nanocellulose "coat" around somebody who has suffered extensive burns can save the person's life if done soon enough.

Research aimed at developing original bionanocellulose dressings began in 2003. The resulting material is called CelMat and has been approved for sale. Industrial production of CelMat has been undertaken by Bowil Biotech, a Polish biotechnology company from the northern town of Władysławowo. Bowil Biotech chief Dariusz Bobiński told the Biotechnologia.pl website that the company has acquired rights to patents, patent applications for inventions and to the CelMat trademark.



Metallic scaffolding covered with bacterial nanocellulose.

Bowil Biotech has built a state-of-the-art production facility that complies with pharmaceutical good manufacturing practice (GMP) criteria. It is getting ready to put CelMat dressings on the market.

The researchers from the Institute of Technical Biochemistry have also found that bacteria that secrete bionanocellulose can be grown on media made from renewable materials such as molasses and cabbage pomace. Most recently, research has focused on other uses of bionanocellulose, including in tracheal tubes and meshes for hernia repair.

Paweł Patora
Dziennik Łódzki

WHERE THE PAST INSPIRES

The Łódź University of Technology campus is a unique site occupying 32 hectares.

The larger part of the campus lies on former factory land. Historical industrial facilities and original residences that once belonged to factory owners are scattered among the university's new buildings. Meanwhile, two well-maintained municipal parks in the direct vicinity are a perfect place to relax.

When the Łódź University of Technology was founded in 1945, the city authorities gave it almost 8 hectares right next to the downtown area. This was land that had earlier belonged to industrialist Szaja Rosenblatt, who from the 1870s had built units of his cotton factory there. The factory complex, comprising buildings that once housed spinning mills, weaving mills, warehouses and offices, was adapted to the teaching and research needs of the first three faculties: Mechanical Engineering, Chemistry, and Electrical Engineering.

As time went on, the university took over more space. Premises that were part of Łódź's historical fabric but not easy for a university to use were supplemented with new buildings. Newly founded faculties received their own separate headquarters. The university's rapid development in the 1990s consolidated its already strong position among Poland's technical universities. New courses and constantly expanding areas of scientific research required not only advanced equipment but also premises suited to the changing requirements.

A decision made in the 1990s to buy land with factory buildings and residences (owned by the Schweikert family before World War II) from the Lodex and Fagum-Stomil companies proved farsighted. Prof. Jan Krysiński, the university's rector

at the time, saw huge potential in the former factory facilities standing unused within the campus. He initiated redevelopment of the Łódź University of Technology's postindustrial buildings, a process that continues to this day. The first project was a ruined former warehouse and office building that was once part of the Schweikert industrial empire. In 1997 it was handed over to the Faculty of Process and Environmental Engineering. The biggest project in the former Schweikert factory complex was the comprehensive redevelopment of a four-story building where woolen goods were once made. Today, with 12,000 square meters of space, it is the university's biggest building and home to three faculties. It stands out among other former industrial facilities: it is over 150 meters long. The five-story former warehouse that once belonged to the Fryderyk Wilhelm Schweikert Woolen Goods Joint-Stock Company was remodeled to house the Łódź University of Technology's library.

The next stage of the university's expansion included the construction of the new Faculty of Mechanical Engineering building, which involved adapting buildings that were once part of the Rosenblatt cotton empire. One of these houses a "Factory of 21st-century Engineers," which is a modern building with top-class facilities supported by the latest ICT systems for students on courses dealing with advanced technologies.

"This project fits in perfectly with Łódź's development strategy. The building is being created keeping in mind the needs of companies that employ highly qualified staff," says Prof. Stanisław Bielecki, the Łódź University of Technology's rector. Apart from classrooms, the building includes specialist laboratories where advanced technologies are developed for many sectors of the economy, such as the automotive industry and the renewable energy sector, as well as for use in medicine.

The university's most recent project in terms of redeveloping former factories was the conversion and expansion of the former Paul Desurmont, Motte & Co. Worsted Wool Spinning Mill complex to house the Faculty of Technical Physics, Information Technology and Applied Mathematics. The new premises together with the converted factory form a uniquely equipped building that is extremely user friendly. The historical industrial architecture merged with new space designed to accommodate innovative teaching methods not only serves the university's students but is also used for classes and laboratory presentations for Łódź school pupils.

Near these historical facilities lies the new Information Technology Center, the outer appearance of which references Łódź's industrial architecture. Inside are 21 specialist laboratories with work stations fitted with the latest hardware.

The new building of the Faculty of Process and Environmental Engineering will be completed soon. It will include laboratories for courses in fields considered as priorities for the Polish economy, including process engineering, biochemical engineering and environmental engineering. This will be one of the most advanced buildings of its kind in Poland. Its laboratories will be equipped with the latest technology used in industry. The look of the new building fits in perfectly with the postindustrial and modern setting of the changing campus and the neighboring buildings of the "Factory of 21st-century Engineers" and the International Faculty of Engineering.

The architecture of the Łódź University of Technology's postindustrial facilities is supplemented with six historical residences that once belonged to industrialists. The oldest residence is the former house of Fryderyk Schweikert from the second half of the 19th century, which was remodeled in a neo-Renaissance style at the end of the century. Nearby are two exceptional houses built by the Richter family. The architecture of the first one, built for Józef Richter, has eclectic interiors with echoes of the Renaissance. The other one, which belonged to Józef's brother Reinhold, represents eclecticism at its fullest. The architecture and decoration includes Gothic, Renaissance, Mannerist and Art Nouveau influences. The university rector's office is housed in this residence with an unusually romantic flavor.

Marek Pabich
Institute of Architecture and Urban Planning

POLYMERIC BIOMATERIALS

Researchers from the Łódź University of Technology's Institute of Applied Radiation Chemistry have developed an innovative hydrogel dressing for the treatment of diabetic wounds.

The new dressing is based on another type of hydrogel dressing that has been available for 20 years and patented in Poland, the United States, Britain and Germany. The older type of dressing has so far been used to treat tens of thousands of burns, bedsores and trophic ulcers. Like the older type, the new dressing was developed by a team headed by Prof. Janusz Rosiak. The newer dressing contains a substance from the tetrapeptide group of organic compounds, delivering it straight to diabetic wounds. When the tetrapeptide reaches its target, it stimulates the growth of new blood vessels, which helps halt the necrosis of tissues in the wound. The researchers say their invention can result in fewer amputations.

Applying a hydrogel dressing

Applied directly to a wound, hydrogel dressings do not stick to it, allowing oxygen to penetrate the wound while shielding it from external infections. Such dressings also ease pain and absorb fluids that seep out of wounds. At the same time, they maintain a moist environment. Importantly, hydrogels absorb necrotic tissue, so when a dressing is removed, so is the dead tissue. Dressings of this kind release drugs at a specified rate, so that a doctor's intervention is not necessary.

The tetrapeptide in the new dressing is naturally present in the human body and has a relatively short half-life of around five minutes when in the bloodstream. That means its concentration level is very low in a healthy organism. When tetrapeptide is injected into tissues around a wound, the area where it is active cannot be precisely controlled. Injections produce high concentrations very quickly, after which the tetrapeptide vanishes just as rapidly. This limits the therapeutic benefits of such injections. Meanwhile, the hydrogel dressing components produced with the method used by Rosiak's team are first mixed in water and then placed in the packaging of the dressing. Tightly sealed, the dressing is then sterilized with an electron beam, producing a sterile hydrogel patch or sheet with tetrapeptide that is ready to be gradually released into a wound.

The use of ionizing radiation to sterilize the dressings and trigger chemical reactions in them has also allowed the researchers to devise technology for other medical products. One example is hydrogel systems for induced childbirth. In addition to inducing labor, such systems make labor less painful for the mother. Hydrogel biomaterials have so far been used by more than 300 women giving birth and proved highly effective.

The Łódź researchers have also designed a range of polymeric biomaterials for application in tissue engineering. The materials include tissue scaffolds used to grow new nervous tissue and skin as well as hybrid artificial organs. In the case of organs, the researchers focused on polymer casings for transplanted tissues (islets of Langerhans, thyroid cells), designed to protect the tissues from the recipient's immune system and enable them to function properly over extended periods of time.

The achievements of Rosiak's team also include a unique method to produce polymeric nanogels and studies on how such nanogels can be used in drug delivery systems. The method aims to minimize the toxic effect drugs can have on patients, especially in cancer therapy. This method also enables the selective delivery of drugs to specific areas of the body. Prof. Piotr Ulański, who is in charge of this research, is working on specific nanogel systems with researchers around the world, including those from the Massachusetts Institute of Technology.

For further information on the team's research, go to http://mitr.p.lodz.pl/biomat.

Janusz M. Rosiak
Institute of Applied Radiation Chemistry

Michał Staśkiewicz

Polish-Swiss team at the EMPA laboratory in Switzerland after testing a strengthened bridge girder

INNOVATIVE BRIDGE STRENGTHENING SYSTEM

A Polish-Swiss project that aims to develop the world's first bridge strengthening system using unanchored pre-stressed carbon fiber reinforced polymer (CFRP) laminates is in progress at the Łódź University of Technology's Faculty of Civil Engineering, Architecture and Environmental Engineering.

The Innovative Structural Health Monitoring in Civil Engineering Infrastructure Sustainability (TULCOEMPA) project is interdisciplinary and combines construction technology with long-term monitoring of bridges in terms of their "structural health." The project, which has been financed under a Polish-Swiss research program, began Oct. 1, 2011.

Before the new system is applied in practice on an existing bridge, the researchers conducted stress tests at the EMPA laboratory in Zurich on special replicas of structural bridge components.

The new strengthening method is innovative in that there are no anchors used at the ends of the pre-stressed carbon fiber reinforced polymer laminates. The method makes it possible to quickly and efficiently strengthen bridges without using conventional steel anchors that may be susceptible to damage and corrosion.

Two teams specializing in construction and advanced IT technology are working together on the project. The condition of the structure after reinforcement will be monitored using modern data acquisition systems and wireless networks. Special sensors will be used to measure any deformation or displacement in the structure, combined with a vehicle detection system based on the analysis of images, sound, vibrations, and electromagnetic field data.

The new method will reduce the time needed to strengthen a bridge. It will also reduce the risk of corrosion, including galvanic corrosion, which poses a danger to bridges.

The new method can also be used on other types of structures and buildings.

Renata Kotynia
Faculty of Civil Engineering, Architecture and Environmental Engineering

INNOVATION FOUNDED ON TRADITION

The Łódź University of Technology's Department of Material and Commodity Sciences and Textile Metrology, in existence since 1947, is one of the university's best equipped and most rapidly developing research units.

Composite obtained through combining dual-component alginate fabric with a nanofiber layer

The department specializes in applying the latest analytical techniques (advanced spectroscopic, microscopic, X-ray and other methods) as well as introducing many technical solutions that find practical application.

Textronic applications

In response to the steadily growing need for new, multi-purpose textiles that can be seen in many areas of life and technology, the department has developed a number of materials for building textronic systems, including:

- fiber-forming polymers with electroconductive and sensory properties
- multi-purpose ink compositions based on polymers and electroconductive nanoparticles
- technologies for making textronic materials involving surface modification with spray coating techniques
- piezoelectric fiber technologies.

In association with other units, the department also works on new applications for textronic systems designed to protect workers in hazardous conditions. Projects completed so far include miniature radio transmitters and receivers that enable a person's vital signs to be monitored through miniature textile sensors, among other things. These sensors are placed in clothing in order to record changes in body temperature, cardiac function, pulse and breath.

Applications of chitin and its derivatives in regenerative medicine

Research is being conducted at the department on practical applications for chitin copolyesters soluble in typical organic solvents. Synthesis of new chitin copolyesters is ongoing. As a result of a collaboration with industry, the department is carrying out a project financed by the National Center for Research and Development (NCBR) whose purpose is to support business in the domestic and international launch of dressings that speed up healing of hard-to-heal wounds. Research on chitin copolyesters will lead to the development of new products for regenerative medicine.

Production of hybrid implantation materials

The department's scientists have built a prototype multilayered implantation material for treating bone tissue loss. The composite was obtained through combining dual-component alginate fabric with a nanofiber layer.

Izabella Krucińska

UNIVERSITY FOR THE BIO-ECONOMY

The Łódź University of Technology was one of the first universities in Poland to begin intensive research into a range of issues related to the bio-economy.

The main areas of this research are:

- developing processes for obtaining energy and chemicals with high added value from biomass derived from waste and vegetation using industrial biotechnology methods;
- obtaining new biomaterials and polymer composites of controllable biodegradability based on cellulose nanofibers and bionanocellulose;
- developing technologies for obtaining new biocatalysts and biocatalyst mimetics for the production of fuel and organic chemical compounds of substantial industrial significance (platform molecules) from biomass;
- developing biotechnological processes for producing functional foods useful in preventing and treating diet-related diseases;
- developing new ways of integrating fermentation and bioconversion processes with product separation, purification and batching;
- developing biorefinery processes based on waste and renewable resources.

The Łódź University of Technology is carrying out a number of projects that are directly connected with the goals of the bio-economy. The university is a leader of two projects nearing completion that are supported with EU funds as part of the Innovative Economy Operational Programme: "Utilization of Biomass for the Preparation of Environmentally Friendly Polymer Materials" (BIOMASA) and "Biodegradable Fibrous Products" (BIOGRATEX).

The university is expanding its operations, as proved by submitted project proposals such as the Bio-economy Center as well as a Teaming up for Excellence project under the H2020 Framework Programme to establish an International Center for Research on Innovative Biobased Materials (ICRI-BioM).

The Łódź University of Technology has extensive experience in bio-related research. The university's rector, Prof. Stanisław Bielecki, created what is known as the Łódź school of industrial biotechnology, building a strong bio-research center in Łódź that has won national and international recognition. The BioTechMed Advanced Technology Center was initiated and is coordinated by the university. The university is involved in the work of the Center of Excellence for Biotechnology and Industry, the Polish Biotechnology Federation and the European Center of Bio and Nanotechnology. The university's role in setting up the BioNanoPark and the TechnoPark in Łódź has also been significant.

The university played a key role in the formation of the Polish Bio-economy Technology Platform, in which Prof. Bielecki chairs the Coordinating Committee.

The Łódź University of Technology is also a member of the Polish Technology Institute, which focuses on integrating Polish R&D potential as well as intensifying research and development projects involving businesses, carrying out research projects and programs of key importance to the Polish economy and improving the level of innovation in the economy through the development of strategic Polish technologies.

Beata Kolesińska
Institute of Organic Chemistry,
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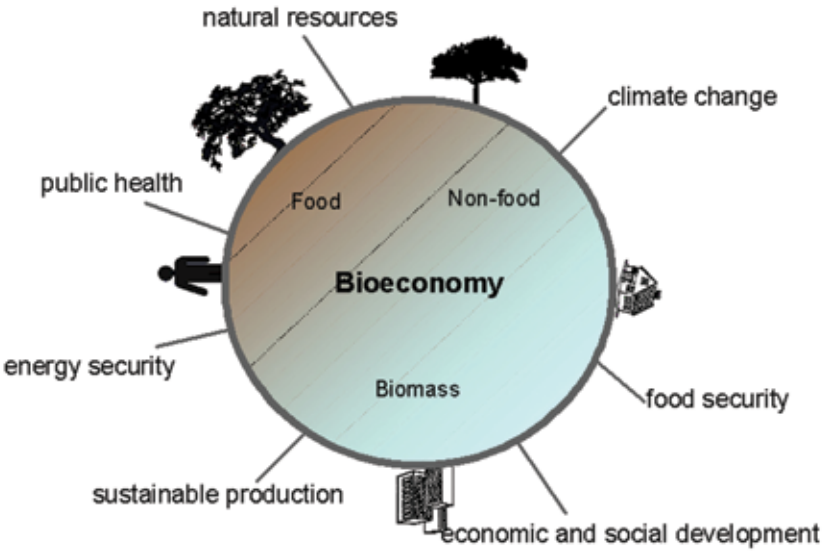

The European Bioeconomy in 2030

GREEN ENERGY FROM SEWAGE

Researchers from the Łódź University of Technology's Institute of Fermentation Technology and Microbiology have invented a method that uses microorganisms to remove contaminants from biogas.

An installation based on the innovative technology will soon be launched at the Grupowa Oczyszczalnia Ścieków sewage treatment plant in Łódź. The facility produces 18,600 cubic meters of biogas from organic sediments a day, which is enough to generate all the heat the facility needs as well as half of the electricity it uses. Biogas accounts for around 13 percent of all renewable energy produced in the city of Łódź , while Łódź province has 10 biogas installations, with more under way.

Regarded as an environmentally friendly fuel, biogas can help Poland become less dependent on other sources of energy, while making energy cheaper to obtain. The calorific value of biogas, which mainly consists of methane, is reduced by the hydrogen sulfide (H_2S) and carbon dioxide (CO_2) it contains. A project carried out by the Institute of Fermentation Technology and Microbiology, which is part of the Łódź University of Technology's Faculty of Biotechnology and Food Sciences, aimed to develop innovative bioconversion technology to treat biogas contaminants, H_2S in particular. Prof. Maria Koziołkiewicz, dean of the faculty, says this is one of the university's largest projects being carried out jointly with an industrial partner. The team-up with the Łódź University of Technology has provided the local sewage treatment plant with one of the world's first systems where microorganisms are used to remove contaminants from biogas. The method invented by researchers from the Institute of Fermentation Technology and Microbiology offers a good alternative to chemical processes, as it eliminates all the difficulties that arise with chemical H_2S removal methods.

Agata Bednarek

Project manager Krzysztof Ziemiński tests effectiveness of biogas treatment at experimental facility.

Krzysztof Ziemiński, D.Sc., who manages the project, says the bacteria in the system are the most innovative component of the new technology. "This innovative concept makes it possible to cut the costs of biogas production and processing," says Ziemiński. "We do not dilute the biogas with air; we do not reduce its calorific value, and the installation does not require any extra safety devices. No chemicals are added, the technology is environmentally friendly and the biogas costs less to obtain than in H_2S removal methods used so far."

The microorganisms that the researchers have used grow on filter pellets made of carefully selected materials and soaked in a special substance. They form a mucous film around the pellets, similar to the layer of algae that covers rocks in rivers. The bacteria remove almost 100 percent of contaminants from biogas.

The installation was mounted at the sewage treatment plant in Łódź following over two years of industrial research. "Businesses that operate in the renewable energy sector are looking forward to innovative, effective and cheap biotechnological methods to purify biogas," says Ziemiński. "Our project meets these expectations."

Working with the sewage plant, researchers from the Łódź University of Technology were able, right from the start, to test their innovative technology in a real-life environment. The tests proved so promising that the treatment plant managers bought a license from the university and decided to start biological biogas treatment at the facility. The first installation, in one of the plant's two H_2S removal systems, will be launched in June this year and the other one next year.

The project has also provided the Institute of Fermentation Technology and Microbiology with a state-of-the-art laboratory to conduct research and measurements. Cutting-edge equipment for the laboratory cost around zl.1 million and enables advanced chromatographic, microbiological and analytical studies.

The innovative technology using microorganisms cost over zl.3.5 million to develop, 85 percent of which came from the EU and the remainder from Poland's Ministry of Science and Higher Education.

Ewa Chojnacka

CUSTOMIZED DIETS

Two young branches of science, nutrigenomics and nutrigenetics, help scientists design new food products and diets tailored to the needs of senior citizens and people at risk of developing medical problems caused by their diet.

Research into the molecular mechanisms of food engineering could have a major impact on what we eat. In Poland, such research is conducted by the Department of Food Biochemistry and Nutrigenomics at the Łódź University of Technology's Institute of Technical Biochemistry.

Derived from molecular biology, nutrigenomics aims to identify the effect bioactive components of food have on genes, or more specifically, on gene expression, which is the synthesis of RNA and proteins based on genetic information. Bioactive food components include vitamins, polyphenols, carotenoids, unsaturated fatty acids and many other natural compounds. From the perspective of nutrigenomics, these are signal molecules that transfer external information into cells and affect gene expression. The Department of Food Biochemistry and Nutrigenomics studies how these compounds work.

Research on the biological activity of nutrients conducted in the laboratory of model human and animal cell cultures

Nutrigenetics is a branch of genetics that identifies and studies minor genetic differences between individual people. Slight as they are, such differences are responsible for the susceptibility of some people to obesity and other diet-related medical problems. Companies encourage people to test themselves for such individual genetic differences. However, this is a highly complicated matter and the differences are very hard to identify. They can be roughly divided into single-nucleotide polymorphisms (SNP) and copy number variations (CNV). Single-nucleotide polymorphisms have been well researched and some of them can be identified with genetic tests. Studies on copy number variations, in turn, began only recently and these differences are possibly more important than SNPs.

The growing interest in nutrigenetics and nutrigenomics is a result of the serious risks presented by diet-related diseases. While there is no single obesity gene, or even a group of genes that make us gain weight, obesity is nevertheless a condition of genetic origin. The human genome comprises 25,000 genes, many of which can take alternative forms called alleles. When several dozen genes are present as certain alleles, the risk of developing obesity increases, making a person with such alleles more susceptible to risk arising from a high-calorie diet and insufficient physical activity. Trying to identify the genes and alleles that form the genetic basis of obesity and other metabolic diseases is neither an easy nor a fast process. Currently available tests allow for the identification of no more than 20 gene variations and in reality, they are more of a fad than a rational method of counteracting the risk of obesity.

The homo sapiens species evolved 150,000-200,000 years ago and for most of that time people lived differently than they do at present. In the past 10,000 years, people chose a settled way of life, started to grow crops and breed animals. Our diets and lifestyles have changed dramatically and contemporary people eat more carbohydrates and fats than before while being less physically active. Meanwhile, the human genome changes much slower than diets and lifestyles. Nutrigenomics and nutrigenetics might help devise different kinds of diets for specific individuals and risk groups, but at the end of the day, they cannot become a magical cure for obesity, type-2 diabetes and other diet-related diseases.

Maria Koziołkiewicz
Institute of Technical Biochemistry
Department of Biotechnology and Food Sciences

TRAINING THE ENGINEERS OF THE FUTURE

The Łódź University of Technology's mission is not just to build up its scientific and research potential but also to create a modern center of education where innovative teaching gives students the skills that today's engineers need.

The skills essential to function effectively in a global labor market include the ability to communicate in an international and multicultural environment, supported by proficiency in at least two foreign languages. For more than 20 years, the university has had an International Faculty of Engineering, which specializes in training engineers through a program taught exclusively in English or French. Among other things, students gain experience by spending several months at one of 300 partner universities as part of their "mobility window"—one semester during which they have no classes to take at their home university.

Every year the International Faculty of Engineering accepts more than 300 foreign students under the Erasmus program. They make up over 20 percent of the student community. This translates into significant internationalization of even the smallest student groups. Extensive collaboration with foreign universities, a substantial contribution by professors from all over the world in the teaching process, and an emphasis on the exchange and transfer of good international practice to education means that students have to function in a world of many cultures.

One major constituent of the Łódź University of Technology's identity comes from agreements on double degrees, of which the school has signed a dozen or so. This is a huge opportunity for students to obtain confirmation of their skills and abilities not only from their home university but also from a leading foreign university.

Besides intensively developing international contacts, the Łódź University of Technology attaches great importance to implementing innovative teaching methods. The university operates a student-centered system. In an era of technological progress and easy access to information, traditional teaching methods in which students play a rather passive role are on the way out. More innovative teaching methods are being introduced that are largely based on problem-based learning. Unlike the classic lecture system, in problem-based learning students actively seek out knowledge and then—with the help of a teacher-mentor—learn how to use that knowledge to solve all kinds of engineering problems.

"Design thinking" is a special kind of problem-based learning. This method aims to have students diagnose the needs of a given environment and then effectively implement solutions that respond to those needs, taking into account the actual circumstances at companies. For this to work, it is essential to get companies involved in the teaching process. Through various forms of collaboration with businesses (projects, joint teaching of classes, discussion forums, competitions), the university enables students to solve real problems that companies face. Thanks to this, education is strongly linked to real-life issues faced by today's businesses.

Dorota Piotrowska
International Faculty of Engineering