

Annual scientific awards of the Division IV Technical Sciences of the Polish Academy of Sciences in 2010

For many years it has been a great tradition of the Division IV of Technical Sciences of the Polish Academy of Sciences to recognize the outstanding achievements of young scientists with several Awards related to various fields of technology. The awarded candidates have to satisfy the requirements specified in suitable Regulations. In 2010 the Scientific Award Fund of Division IV was supported by the well known international company Siemens which significantly augmented the status of the Awards. The list of Awarded Winners and the brief description of their achievements prepared by the authors are as follows.

In the field of Thermodynamics:

Method of evaluation of ecological effects in thermal processes with the application of exergy analysis

Wojciech Stanek

Silesian University of Technology

The presented work is devoted to the problems of the depletion of non-renewable natural resources. The methodology of thermoecological cost expressing cumulative exergy consumption of non-renewable natural resources has been developed. The iterative algorithm of determination of the thermoecological cost of imported goods is worked out. Such an algorithm is the basic tool for determination of the indices of thermoecological cost. The thermoecological cost calculation methods concerning the cogeneration and multi-product processes are also developed. The method of calculation of the thermoecological cost of harmful substances has been supplemented by tools for calculation of thermoecological abatement cost. The life-cycle analysis methods have been included into the thermoecological cost methodology. The algorithms and procedures for thermoecological cost minimization have also been worked out. The developed algorithms and procedures represent a comprehensive tool toward investigations of the influence of human activities on the depletion of non-renewable natural resources. Several practical examples of thermoecological cost calculation have been presented. Among others the author analyzed the influence of interregional exchange (import/export) upon the results of thermoecological cost indices. The thermoecological cost of some

selected useful products is calculated. The influence of industrial system upon depletion of natural resources is investigated and also thermoecological cost of electricity and heat within life cycle is determined. The presented work includes also an example of thermoecological optimization of design and operational parameters.

In the field of Electrotechnics:

Investigations of static electrification phenomenon in liquid dielectrics

Wojciech Zdanowski

Opole University of Technology

The series of works published (among others, in IEEE Transactions on Dielectrics and Electrical Insulation, Journal of Electrostatics, Materials Science – Poland) shows research results on the static electrification phenomenon generated during the flow of liquid dielectrics.

Dielectric liquids are used for cooling such appliances as X-ray lamps, hermetic type engines and semi-conducting heat exchangers or electric power transformers. Electrification of liquid may, in some cases, impose hazard. In electric power industry this phenomenon may lead to the permanent insulation damage in high-power transformers, in which an induced oil circulation is used in order to intensify heat delivery. In petrochemical industry there occurs a significant fire and explosion hazard especially during fuel pumping operations and transport. Electrostatic charges generated may initiate fuel ignition during refueling at gas stations, pipeline failures and tanker explosions. The research carried out by author consisted in determining the dependency between the amount of the current generated and static electrification voltage, and parameters connected with the flow and physicochemical properties of insulation oil, oil fuels, pure hydrocarbons and their mixtures. A significant aspect of the research was finding an effective way of limiting electrostatic charging tendency (ECT) of liquid dielectrics based on doping with other chemical components. The development of research methods of both cognitive and prophylactic character constituted another group of issues. The research results obtained contributed to widening knowledge on the mechanisms of occurrence, size and intensity of the electrification phenomenon and the ways of its limiting in a large group of oil products.

In the field of Metallurgy and Structural Metallurgy:

Phase and structural changes in aluminium alloys

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Rzeszów University of Technology

Multi-component AlMgSi aluminium alloys of 6xxx class play important role among light alloys extensively used in the contemporary aviation industry. These alloys are applied to a range of lightweight airframe constructions: shell plating, leading edge and nose flaps, frames, longerons and stiffeners. The process of aluminium alloys design generally results in compromises to achieve the best overall mix of properties (strengthening state) to satisfy the main criteria that determine operational safety and operational reliability. This may be achieved by optimising: chemical composition, Mn and Fe concentration, primary crystallisation parameters and the type, kinetics of precipitation processes during plastic deformation and strengthening heat treatment. Thus, aluminium alloys of this class are continuously being developed through application of new metallurgical and technological processes leading to obtain the chemical and phase composition with morphology and distribution of precipitates of strengthening intermetallics to meet fully the high level of performance requirements of this engineering materials. The state of microstructure of these alloys, formed by technological processes, plays a decisive role in improving mechanical properties, corrosion resistance, weldability and plastic workability. Results of the research were used to elaborate the sequence of the primary intermetallic phase precipitations: $Al_6(FeMn)$, $\alpha_H-Al_6(FeMn)$, $\beta-AlMnSi$ and Al_3Fe formed during crystallization and heat treatment process. The influence of shape, size and relative volume fraction of primary intermetallics and precipitates of stable hardening phase $\beta-Mg_2Si$ on strengthening, plastic properties (R_m , $R_{p0.2}$, A and Z) and crack toughness (K_{IC}) were determined. Transmission microscopy techniques (TEM and SEM) and X-ray diffraction (XRD) were used to identify intermetallic phases. An unique extraction method was developed to isolate the intermetallics providing currently the most thorough characterization of the precipitates for providing essential information to elaborate basic control criterions to ensure their proper: precipitation sequence, chemical composition, morphology and dispersion. These properties strongly affect utilitarian properties of aluminium alloys of 6xxx group.

In the field of Materials Science:

Biomaterials for tissue engineering. Tailoring structure and biological properties of aliphatic polyesters

Elżbieta Pamuła

University of Mining and Metallurgy

The aim of this study was to develop biomaterials for bone and cartilage regeneration according to tissue engineer-

ing approach. These biomaterials based on aliphatic polyesters can be considered as a new generation materials, which can mimic natural tissue structures and functions, able to trigger required, specific, and time-dependent effects in biological environment.

In this study the following problems have been analysed: i) selection of the raw polymeric materials characterised by high biocompatibility and optimal degradation and resorption time; ii) the surface modification of these materials (chemistry, topography, protein immobilization, hydroxyapatite deposition) in order to provide a specific surface interaction with cell receptors; iii) processing of the raw polymeric materials into three-dimensional scaffolds mimicking an extracellular matrix of a bone and/or a cartilage, which macroscopic properties would be advantageous for in vitro cell growth and in vivo tissue regeneration.

It was shown that resorbable biomaterials for tissue engineering should be tailored at three length scales: i) the nanometer scale responsible for a protein adsorption, interactions ligand – receptor and cell adhesion; ii) the micrometer scale responsible for a cell infiltration into a porous implant and diffusion of nutrients and wastes, and iii) the macroscopic level – responsible for vascularization and integration of the biomaterials with the host tissue.

It was also demonstrated that biological properties of aliphatic polyesters depend on their composition, surface chemistry, topography as well as the degradation mechanism and the resorption time. It was proved that the adequate surface modification of these biomaterials results in creation of materials having properties more favorable for cell adhesion and tissue regeneration.

In the field of Informatics:

Decision making in tasks with incomplete information

Robert Nowicki

Częstochowa University of Technology

Decision making is an integral part of almost every process. In the age of automation the decision systems become crucially significant. Most of the solutions proposed in this area imply a specific set of so-called conditional attributes, knowledge of which values are necessary to carry out e.g. a process of inference. In real tasks, the available set of attribute values may differ from that provided during the design of the decision-making system. Moreover, in specific cases, knowledge of the value of all conditional attributes of the decision-making process is not necessary to make the decision. One can make use of an example described in the introduction to my book “Fuzzy decision support systems for tasks with limited knowledge” (in Polish). The example applies to medical diagnostics. Note that each parent is constantly monitoring the health of her/his child. This does not mean that every day he or she performs blood and urine analysis, performs tomography, x-rays of all the organs, or other cumbersome and

expensive examination. To conclude that the health is good, it is enough to observe its behaviour. Only when the child's behaviour is different from the normal, the information derived from an observation is insufficient.

The research concerns the design of decision systems that are built on the knowledge stored in the form of fuzzy rules; they perform for different sets of conditional attributes with known values. Depending on which data are available in a particular case, developed systems indicate the particular decision or refuse to answer. This latter case indicates that the entered data are not sufficient to make a decision. The solution utilized, in addition to the fuzzy set theory, the theory of rough sets was created by the Polish professor Zdzislaw Pawlak.

In the field of Architecture:

**Theory of modern architecture.
Modern architecture.
Polish modernist architecture**

Roman Rutkowski

Wroclaw University of Technology

As an architect performing my profession in the practical way and interested in the contemporariness, I direct my attention towards architecture that is built now or has been built recently. My theoretical works focus on three basic issues: analysis and theory of contemporary architecture regardless the place it is conceived and erected, analysis and popularization of the contemporary Polish architecture and defense of the Polish architecture of the post-war modernism.

In the series of works concerned with the first issue I look at various off-architectural problems of the present time, researching their influence upon the architecture, and at tendencies that happen in the very field of architecture. My observations are verbalized in articles that either are general reflections on today's architecture or are based on important events as Architecture Biennales in Venice.

In the series of articles concerned with the second issue I depict the contemporary Polish architecture in the context of European and world architectural production, both in a general sense, as a social phenomenon, and in a detailed view, as a description of the most exceptional and the most characteristic examples, realized or still remaining fancy speculations.

In the series of activities concerned with the third issue I popularize the most valuable architecture of the Polish post-war modernism, placing it in a broader perspective of XX cen-

ture. This architecture, pejoratively associated with the previous political regime, for the last two decades has been seriously neglected, although in some cases it deserves a special care or even a conservatory protection.

In the field of Machine Building and Operation:

**Fatigue damage assessment
with spectral method**

Adam Niesłony

Opole University of Technology

Elements of machines and structures subjected to service loadings of a suitable level undergo the fatigue process. This process causes growing at time loss of the initial mechanical properties and leads to the element fracture by formation of the fatigue crack. Such fractures often occur in elements of complicated shapes, loaded by many independent random forces. In such cases, application of traditional methods of fatigue life determination where the life is estimated in one, the most strained point of the structure, is difficult because a location of that point has not been known before the crack occurrence.

The awarded cycle of publications concerns a prediction of the places of the crack occurrence with the spectral method. Here, a map of the fatigue damage parameter is used. They are elaborated with the local methods of the fatigue life calculation joined with the finite element method and the advanced software for visualization the results. An application of the spectral method allows performing calculations in the frequency domain and taking into account the system dynamics causes that the calculations are very efficient. Before the calculations, the chosen criteria of multiaxial fatigue were formulated in the frequency domain, and new criteria, based on the power spectral density of shear and normal stresses on the octahedral plane were proposed. The proposed algorithm for the determination of the fatigue damages map was verified according to the tests existing in literature and performed by the author. From the presented examples of calculations it appears that time and place of occurrence of a fatigue crack initiation was determined with satisfactory accuracy.

It is expected that the proposed method will be applied by engineers in order to identify the places of fatigue crack initiation at the stage of formation of prototypes of new elements and determination of the remaining time of application of the existing elements. In future, the method should be developed in order to obtain a better convergence of the calculation results and the fatigue changes observed at real structures.

Actualities

With a great pleasure we announce that Professors: Jerzy Klamka and Bogusław Major, members of the Board of Co-editors of the Bulletin of the Polish Academy of Sciences: Technical Sciences, were elected as the Full Member of PAS and the Corresponding Member of PAS, respectively.



Jerzy KLAMKA was born in Poland, in 1944. He received the M.S. and Ph.D. degrees in Control Engineering from the Silesian Technical University in Gliwice, Poland, in 1968 and 1974, respectively. He also received the M.S. and Ph.D. degrees in mathematics from the Silesian University in Katowice, Poland, in 1971 and 1978, respectively. In 1981 he received habilitation in Control Engineering, and in 1990 titular professor in Control Engineering from the Silesian Technical University in Gliwice, Poland.

Since 1968 he has been working for the Institute of Control Engineering of the Silesian Technical University in Gliwice, where he is now a full professor. In 1973 and 1980 he taught semester courses in Mathematical Control Theory at the Stefan Banach International Mathematical Center in Warsaw.

He has been a member of the American Mathematical Society (AMS) since 1976, and Polish Mathematical Society (PTM) since 1982. He has also been a permanent reviewer for *Mathematical Reviews* (since 1976) and for *Zentralblatt für Mathematik* (since 1982).

In 1981 and 1991 he was awarded the Polish Academy of Sciences awards. In 1978, 1982, 1990 and 1994 he received the awards of the Ministry of Education. Moreover, in 1994 he was awarded the Polish Mathematical Society award.

In 1991 he published the monograph "Controllability of Dynamical Systems", Kluwer Academic Publishers, Dordrecht, The Netherlands. In the last thirty years he published more than 100 papers in international journals, e.g., in *IEEE Transactions on Automatic Control*, *Automatica*, *International Journal of Control*, *Journal of Mathematical Analysis and Applications*, *Systems and Control Letters*, *Foundations of Control Engineering*, *Systems Science*, *Kybernetika*, *IMA Journal on Mathematical Control and Information*, *Nonlinear Analysis, Theory, Methods and Applications*, *Systems Analysis, Modelling, Simulation*, *Archives of Control Science*, *Applied Mathematics and Computer Science*, *Advances in Systems Science and Applications*, *Bulletin of the Polish Academy of*

Sciences: Technical Sciences, *Mathematical Population Dynamics*, *Lecture Notes in Control and Information Sciences*, *Analele Universitatii din Timisoara*, *Acta Mathematicae Silesianae*. He took part in many international Congresses, Conferences and Symposiums.

His major current interest is controllability theory for linear and nonlinear dynamical systems, and in particular controllability of distributed parameter systems, dynamical systems with delays, and multidimensional discrete systems.

Since 2007 he has been the deputy Vice Director of the Institute of Theoretical and Applied Informatics of the Polish Academy of Sciences in Gliwice. In 2002 he was elected as a corresponding member of the Polish Academy of Science.

In 2010 he was elected as a full member of the Polish Academy of Sciences.



Bogusław Jan MAJOR was born in Wieliczka (Poland) in 1945. He received the M.S. at the AGH University of Science and Technology in Cracow in 1970. PhD and DSc (habilitation) he received in Materials Engineering and Metallurgy at the Institute of Metallurgy and Materials Science of the Polish Academy of Sciences in Cracow, Poland.

Since 1970 he has been employed at the Institute of Metallurgy and Materials Science of the Polish Academy of Sciences in Cracow, where he is now a full professor. In the period of 1999–2003 he was a deputy director of the Institute and since 2003 till 2011 he has been a director of the Institute. In 2010 he was elected as a corresponding member of the Polish Academy of Sciences.

His current main scientific interest is focused on the intersection of materials engineering and medicine. Functionally graded materials, biomedical and tribological coatings, laser processing for deposition and surface modification by remelting and alloying of metallic systems are of his interest.

His efforts are directed to the development of engineering surfaces which could elicit rapid and highly precise reaction with cells and proteins, tailored to specific applications. Blood contacting materials applied in cardiovascular devices are of the main interest. The research activity is focused on modern and advanced laser deposition methods, even hybrid ones for coating fabrication as well as the advanced structure diagnostics with the application of XRD (X-ray diffraction), SEM (scanning electron microscopy), TEM and HRTEM (conventional and high resolution transmission electron microscopy),

SAM (scanning acoustic microscopy), confocal microscopy (dedicated to molecular biology).

These facilities would be offered for examinations and are located at the Institute of Metallurgy and Materials Science of the Polish Academy of Sciences in Krakow in Accredited Testing Laboratory No AB 120 which meets requirements of the PN-EN ISO/IEC 17025:2005.

Till now he has published more than 260 papers in referred journals and periodicals, and the most relevant published during last 5 years are dealing with:

- Structure and biocompatibility of TiN coatings on polyurethane produced by laser ablation, e-Polymer no 0026 (2005);
- Laser Processing for Surface Modification by Remelting and Alloying of Metallic Systems, Materials Surface Processing by Directed Energy Techniques, Chapter 7, Elsevier, 2006;
- Crystallographic aspects related to advanced tribological multilayers of Cr/CrN, Ti/TiN produced by the pulsed laser deposition (PLD), Surface and Coating Technology, Elsevier, 2006;
- The influence of high temperature plastic deformation on magnetic properties of Ni₂MnGa type single crystals, Arch. Metal. and Materials 34 (2009);

- Polish Artificial Heart – material, technology, diagnostics, Bull. Pol. Ac.: Tech. 58 (2010);
- Tailoring of Tissue-Surface Interaction in Blood Contacting Materials Bentham e-BOOK (2011);
- Functional Blood Contacting Materials; Fabrication and Diagnostics, InTech – Open Access Publisher (2011).

He has a membership in six Scientific Boards and Scientific Committees such as: Committee on Materials Science of the Polish Academy of Sciences – v-ce president; Committee on Metallurgy of the Polish Academy of Sciences – member; Commission of the Technical Science Polish Academy of Arts and Science – member.

He was awarded by: the Prize from the President of the IV Division (Technical Sciences) of the Polish Academy of Sciences (1973, 1981, 1988); The Prize in the Year of the Polish Science (1973), the Prize of the Polish Academy of Sciences and the German Academy of Sciences (1975), the Prize of the President of the Polish Academy of Sciences (2004), the Prize of the Polish Ministry of Science and Informatization (2005), the Bachelor Cross of Order of the Polish Revival (2005).

He is Co-editor of the Bulletin of the Polish Academy of Sciences: Technical Sciences; Section: Materials Science and Engineering.