Sergey Shevtsov

Sergey Shevtsov October 2016

CURRICULUM VITAE & LIST OF PUBLICATIONS

Personal data

Name	Sergey Shevtsov
Date and place of birth	Sept. 10, 1949 Rostov on Don, Russia
Address and phone number at work	Mechanics of aircraft systems and technologies Lab., South Center of Russian Academy of Science, Tchekhov str., 41, Rostov on Don, Russia, 344006 +7 8632509810 Mathematical modeling dept., Southern Federal University, Milchakov str., 8A, Rostov on Don, Russia, 344090, +7 8632975111 Aircraft engineering dept., Don State Technical University, Novatorov str., 5, Rostov on Don, Russia, 344038, +7 8632977566
Address and phone number at home	Stepna str., 7, Oktyabrsky, Aksay reg., Rostov on Don, Russia, 346717, +7 8635039432, mob. +7 9034013385

Education

BSc – 1969 – The Rostov College of Radio, Electronics & Automatics
The Faculty of Radar Devices
MSc – 1974 – The Rostov State University
The Faculty of Theoretical Physics
PhD – 1986 – Don State Technical University,
Department of Physical and Mechanical Machining
Title of thesis: “Vibration of the high precise details for residual stress reduction”
DrSc – 2001 - Don State Technical University,
Department of Dynamics and Strength
Title of thesis: “Computer modeling of dynamic phenomena in moving granular media”

Employment history

2004 – presently	Head of the Mechanics of aircraft systems and technologies Lab. South Center of Russian Academy of Science
2005 – presently	Part time professor at the Mathematical modeling dept. Southern Federal University
2006 – presently	Scientific advisor at the “Rostvertol Helicopters Co.” (underemployment)
2001 – presently	Part time professor at the Aircraft engineering dept. Don State Technical University
1999 – 2001	Projects leader at the Scientific enterprise “Synthesis”
1989 – 1998	Head of CAD/CAE engineering department at Research institute “Gradient”
1974 – 1989	Researcher, teaching assistant, lecturer, senior lecturer, assistant professor Don State Technical University

Sergey Shevtsov

Professional Activities

(a) Positions in academic administration

2002 – 2013 – Vice Head of Aircraft Engineering Department, Don State Technical University

(b) Membership in professional/scientific societies

2005 – presently – American Institute of Aeronautics & Astronautics (AIAA), American Society of Mechanical Engineers (ASME), Institute of Electrical & Electronics Engineers (IEEE)

(c) Membership in scientific councils for PhD and DrSc degree assignments for the scientific specialties:
Robots and mechatronics at the Southern Federal University
Dynamics and strength of machines at the Don State Technical University

Educational Activities

(a) Undergraduate courses taught

Since 2001 Don State Technical University

Mathematical modeling	Aircraft engineering dept.
Fundamentals of aerodynamics	Aircraft engineering dept.
Dynamics and strength of aircraft structures	Aircraft engineering dept.
Introduction to the finite element computations	Aircraft engineering dept.
Engineering calculations in MathCAD	Aircraft engineering dept.
Control fundamentals	Mechanical engineering dept.
Mathematical modeling	Nanomaterials dept.
Numerical methods of optimization (laboratory)	Mechanical engineering dept.
Modeling of controllers in Simulink (laboratory)	Mechanical engineering dept.
Final project	Mechanical engineering and Aircraft engineering dept.

Since 2005 Southern Federal University, Faculty of mechanics, mathematics and computer sciences

Mathematical modeling in engineering	Mathematical modeling dept.
Models of identification and control	Mathematical modeling dept.

(b) Graduate courses taught (Eng)

Since 2005 Don State Technical University

Modeling of structural dynamics and heat transfer at the aircraft design	Aircraft engineering dept.
Numerical calculations of the wing sections characteristics	Aircraft engineering dept.

Since 2007 Southern Federal University, Faculty of mechanics, mathematics and computer sciences

Numerical methods of structural optimization	Mathematical modeling dept.
Artificial neural network in problems of systems identification	Mathematical modeling dept.
Continuous mathematical models	Mathematical modeling dept.
Controllers design using MATLAB tools (laboratory)	Mathematical modeling dept.
Genetic algorithms and their applications (laboratory)	Mathematical modeling dept.
Academic supervising of MSc students	Mathematical modeling dept.

(c) Academic supervising of PhD students

2001 – V. Axenov – Modeling of vibro-impact tool and surface hardening machining process
2002 – N. Cholodenko – Experimental study of quality and performance for the different types of surface polishing by the flow of abrasive particles
2003 – A. Petryaev - Models and software for direct numerical simulation of the granular medium dynamics
2005 – L. Tamarkina – Multiobjective optimization of the cold-hardenening process to improve the fatigue resistance of aircraft parts
2009 – A. Zadorogny – Optimal design of the vibration equipment using means of computer simulation
2011 – O. Alexeeva – Development of improved testing methods for composite materials of high loaded aircraft structures
2014 – S. Chotchaeva – Aircraft's units assembly using database of virtual models

Scientific projects implementation (since 2010)

I. Contract No.579 (2009-2011) customer - Rostvertol Helicopters Co. "Development of the testing method for resins and prepregs used at the helicopter rotor blade manufacturing" (project leader)
II. Contract No.100/437 (2009-2010) customer - Rostvertol Helicopters Co. "Development of testing method for the short term and long term mechanical properties of composite materials for the helicopter main and tail rotors blades manufacturing" (project leader)
III. Contract No. 686 (2009-2010) customer – Russian Federal Agency of Education "Development of the models, the finite-element technologies and software for solving the modern coupled problem of elasticity" (principal researcher)
IV. Contract No. 731 (2009-2011) customer – Russian Federal Agency of Education "Modeling of fibre reinforced high strength composite materials and their mechanical properties at the environmental action" (principal researcher)
V. Contract P-201 (2010-2011) customer – Russian Federal Agency of Education "Design, dynamic analysis and testing of the scaled model of the main helicopter rotor made from composite materials with intelligent control of vibration level" (project leader)
VI. Joint Russian / Taiwanese project RFBR 10-08-13300 / NSC Taiwan 99-2923-E-022-001-MY3 (2010-2012) "Development of Tests and Theoretical Research Methods for the Properties of the New Piezoceramic Composites and Devices with Investigation Their Applications for Underwater Acoustic Multimedia Communication" (principal researcher)
VII. Contract No. 1.2.11 (2011-2012) customer – Russian Federal Agency of Education "Development of the models, the finite-element technologies and software for solving the modern coupled problem of elasticity" (principal researcher)
VIII. Contract No. 790 (2011-2012) customer – Russian Federal Agency of Education "Up-to-date mathematical and finite element modeling of active composite materials and piezoelectric devices based on them" (principal researcher)
IX. Contract No. 11-08-00884 (2011-2012) customer – Russian Foundation for the Basic Researches (RFBR) "Development of method for integrated estimation of the health state of the materials and structures" (principal researcher)
X. Contract No. 12-08-31350 (2012-2013) customer – RFBR "Optimized design of high sensitive hydro-acoustic receivers on the base of nanoscale piezoelectric active diaphragms" (principal researcher)
XI. Contract No. MI-11-1746-01 (2011-2013) customer – Moscow Mil Helicopter Design Center "Dynamic analysis, comparative embodiments investigation of active

vibration control for the main helicopter rotor using power piezoelectric actuators" (project leader)

XII. Contract No. 13-08-90912 (2013) customer – RFBR: Scientific research of Taiwanese MSc student Jyun-Ping Huang from National Kaohsiung Marine University «Optimal schedule synthesis for cure of high strength polymeric composite structure to ensure the high environmental resistance on the basis of thermal-kinetic analysis and mathematical model of the cure process» (supervisor)

XIII. Contract No. 14-08-31612 (2014-2015) customer – RFBR "Multiobjective optimization of distributed systems" (principal researcher)

XIV. Contract No. 15-08-00849 (2015-2017) customer – RFBR "Development of the numerical and experimental methods of synthesis the optimum structure of glass fiber and carbon fiber reinforced plastics for aircraft applications" (project leader)

Scientific Publications (since 2010)

(a) Monographs

Acopyan V., Parinov I., Shevtsov S., Soloviev A. Definition of Constants for Piezoceramic Materials // NOVA Science Publisher, N.-Y., 2010, pp. 205. https://www.novapublishers.com/catalog/product_info.php?products_id=11404

Slusar B., Flek M., Goldberg E., Shevtsov S. Technology of Rotorcraft Manufacturing. Technology of Helicopter Rotor Blades and Composite Parts Manufacturing // SSC RAS Ed. (2013), 230 p. (by Russian) http://www.google.ru/books?hl=en&lr=&id=pqsdBQAAQBAJ&oi=fnd&pg=PA5&ots=OSzedqPE-y&sig=Y7R_zXG6_wfKkv56CQrLph1IyLQ&redir_esc=y#v=onepage&q&f=false

Shevtsov S., et al. Damages identification in elastic structures. Approaches, methods, analysis // Southern Federal University ed., 2015, 72 PP.

(b) Refereed articles in scientific journals

S. N. Shevtsov, V. A. Akopyan. Active and passive vibration control of aircraft composite structures using power piezoelectric patch-like actuators // In. "Piezoceramic Materials and Devices", NOVA Publisher, N.-Y., 2010, p.285-324. https://www.novapublishers.com/catalog/product_info.php?products_id=11605

S. Shevtsov, M. Flek, V. Acopyan, I. Samochenko, V. Axenov. On the active vibration control and stability of the tubular structures by piezoelectric patch-like actuators // MATHEMATICS IN ENGINEERING, SCIENCE AND AEROSPACE (Cambridge, UK; I&S - Florida, USA), Vol. 2, No. 2, 2011, pp. 145-157. http://nonlinearstudies.com/index.php/mesa/article/view/448

Shevtsov S. N., Akopyan V. A., and Rozhkov E. V. An Approach to the Problem of Damage Identification in an Elastic Rod Based on the Timoshenko Beam Model // Russian Journal of Nondestructive Testing, 2011, Vol. 47, No. 7, pp. 480–490. http://link.springer.com/article/10.1134/S1061830911070072#page-1

S. Shevtsov, I. Zhilyaev, A. Soloviev, I. Parinov, V. Dubrov. OPTIMIZATION OF THE COMPOSITE CURE PROCESS BASED ON THE THERMO-KINETIC MODEL // Advanced Materials Research, Vol. 569 (2012) pp 185-192. http://www.scientific.net/AMR.569.185

V. A. Akopyan, I. A. Parinov, E. V. Rozhkov, S. N. Shevtsov. Acoustic-Emission Methods of Non-Destructive Testing of the Materials and Structures by Using Piezoelectric Sensors for

Damage Diagnostics // In “Piezoelectric Materials and Devices”, NOVA Publisher, N.-Y., 2012, p. 259-304. https://www.novapublishers.com/catalog/product_info.php?products_id=20009

S. Shevtsov, M. Flek and I. Zhilyaev. Modeling and Optimal Design of Power High Stroke Piezoelectric Actuators for Rotorcraft Applications // In “Physics and Mechanics of New Materials and their Applications”, NOVA Science Publisher, N.-Y., 2013, pp. 259-274. https://www.novapublishers.com/catalog/product_info.php?products_id=40740

V. A. Akopyan, Yu. N. Zakharov, I. A. Parinov, S.N.Shevtsov, E. P. C. Wu and J. K. Wu. Theoretical and Experimental Investigations of Various Types Piezoelectric Generators // In “Physics and Mechanics of New Materials and their Applications”, NOVA Science Publishers, N.-Y., 2013, pp. 309-333.
https://www.novapublishers.com/catalog/product_info.php?products_id=40740

V.A. Akopyan, Yu. N. Zakharov, I.A. Parinov, E.V. Rozhkov, S.N. Shevtsov and V.A. Chebanenko. Optimization of Output Characteristics of the Bimorph Power Harvesters // In “Nano- and Piezoelectric Technologies, Materials and Devices”, NOVA Science Publishers, N.-Y., 2013, pp. 111-132.
https://www.novapublishers.com/catalog/product_info.php?products_id=46130

Akopyan, V.A. , Solov'ev, A.N. , Cherpakov, A.V. , Shevtsov, S.N. On a deformation sign for identifying defects on the basis of the analysis of the forms of the natural vibrations of a cantilever with a notch // Russian Journal of Nondestructive Testing, V.49, Issue 10, 2013, pp.579-583. http://link.springer.com/article/10.1134/S1061830913100033#page-1

S.N Shevtsov,, J-K Wu, I.V Zhilyaev, J-P Huang. Multi-Objective Optimization of Distributed RTM (Resin Transfer Molding) Process for Curing the Large Composite Structures with Varied Thickness // Springer Proceedings in Physics, V.152, Advanced Materials, 2014, pp. 71-85 (doi: 10.1007/978-3-319-03749-3_7)
http://link.springer.com/chapter/10.1007/978-3-319-03749-3_7#page-1

S. Shevtsov, L.Chinchan, A.Soloviev, V.Shevtsova, and J.-P.Huang. Mechanical Testing of Polymeric Composites for Aircraft Applications: Standards, Requirements and Limitations // Springer Proceedings in Physics, V.152, Advanced Materials, 2014, pp. 201-222
Doi: 10.1007/978-3-319-03749-3_17
http://link.springer.com/chapter/10.1007/978-3-319-03749-3_17#page-1

CHANG Shun-Hsyung, WANG Fu-Tai, WU Jiing-Kae, SHEVTSOV Sergey N., ZHILYAEV Igor. V. and SHEVTSOVA Maria S. The Multiobjective Design Optimization of pMUT Hydrophone // Applied Mechanics and Materials Vols. 727-728 (2015) pp 660-665 (doi:10.4028/www.scientific.net/AMM.727-728.660) http://www.scientific.net/AMM.727-728.660

S. Shevtsov, I. Zhilyaev, A. Evlanov, I. Tarasov, M. Flek, and L. Chinchan. Multi-objective Optimization of the Cure Cycle at the Closed-Mould Forming of Thick Walled Polymeric Composite Structures // In: Advanced Materials - Studies and Applications, Nova Science Publishers, Inc. (2015), 15 p.
https://www.novapublishers.com/catalog/product_info.php?products_id=53074

S. Shevtsov, I. Zhilyaev, P. Oganesyan, V. Acopyan. A Probabilistic Approach to the Crack Identification in a Beam-Like Structure Using Monitored Mode Shape and Their Curvature Data with Uncertainty // In: Advances in Condition Monitoring of Machinery in Non-Stationary Operations. Applied Condition Monitoring Series, V.4. (2016), Springer Int.Publ. pp. 447-462

A. Soloviev, A. Vatulyan, S. Shevtsov, A. Spogakin. The boundary integral equation based method for damages detection in multilayered elastic structures // CHALLENGE JOURNAL OF STRUCTURAL MECHANICS 2 (1) (2016) 51–59

P. Oganesyan, I. Zhilyaev, S. Shevtsov, and J.-K. Wu. Optimized Design of the Wind Turbine's Composite Blade to Flatten the Stress Distribution in the Mounting Areas // In: The Latest Methods of Construction Design (V. Dynybyl Ed.), Springer, Switzerland (2016)
pp. 335-341

S. Shevtsov, S.-H. Chang. Modeling of vibration energy harvesting system with power PZT stack loaded on Li-Ion battery // International journal of hydrogen energy (Elsevier),2016, 41, 12618-12625

S. Shevtsov, J.-K.Wu, O. Alekseeva. Experimental characterization of strength and elastic compressive properties for unidirectional carbon-fiber reinforced composite // International Journal of Materials, 2016, V.3, pp. 74-78

S. Shevtsov, I. Zhilyaev, P. Oganesyan, V. Axenov. Material Distribution Optimization for the Shell Aircraft Composite Structure // Curved and Layered Structures. 2016; 3 (2): 214–222

(c) Articles Published in Proceedings of International Conferences

S. Shevtsov, D. Tsahalis, M. Flek, I. Samochenko Comparison of active and passive modes of piezoelectric patch actuators for scaled helicopter rotor blade vibration suppression (Paper ID472) // Proc. of the International Conference on Noise and Vibration Engineering – ISMA 2010 (Sept. 20-22, 2010, Leuven, Belgium), pp.441-455. https://www.isma-isaac.be/past/conf/isma2010/proceedings/papers/isma2010_0472.pdf

Shevtsov, **S.**, Flek, M., Samochenko, I., Geizenreder, S. A SLENDER BEAM VIBRATION DAMPING BY SIMULTANEOUSLY OPERATING ACTIVE/PASSIVE PZT PATCHES // Proc. of the International Conference on Structural Engineering Dynamics - ICEDyn2011 (Tavira, Portugal, 20-22 June 2011), p.8

S. Shevtsov, I. Zhilyaev, M. Flek GA based optimization of flextensional piezoelectric actuator for rotorcraft active vibration control // Proc. of the 5th International Mechanical Engineering Forum – 2012 (20- 22 June 2012, Prague Czech Republic), ISBN 978 – 80 – 213 – 2291 – 2, p.851-859. http://www.imef.cz/files/shevtsov_sergey_196.pdf

Shevtsov, S., Parinov, I., Zhilyaev, I., Chang, S.-H., Lee J. C.-Y., Wu, P.-C., Lin C.-F., Wuu, D.-S. Modeling and Optimization of MEMS-Based Acoustic Sensor for Underwater Applications // In "Recent Researches in Applied Mechanics", WSEAS Press (2012), ISBN 978-1-61804-078-7, p.88-93. http://www.wseas.us/e-library/conferences/2012/Vouliagmeni/MECH/MECH-14.pdf

Shevtsov, S.; Zhilyaev, I.; Akopyan, V. A Probabilistic Approach to the Crack Identification in the Beam-Like Structure Described by Timoshenko Beam Model // Proc. of the 9th International Conference on Fracture & Strength of Solids FEOFS 2013 (June 9-13, 2013, Jeju, Korea), p.10. http://feofs2013.org/proceeding/file/oral/OS28-008-Shevtsov.pdf

S. Shevtsov, I. Zhilyaev, V. Axenov. Structural optimization of power flextensional piezoelectric actuator using FE model and genetic algorithm // Proceedings of the 32nd IASTED International Conference on Modelling, Identification and Control MIC 2013; (Innsbruck; Austria; Feb. 11-13, 2013) pp. 213-219. http://www.actapress.com/PaperInfo.aspx?PaperID=455387&reason=500

Sergey Shevtsov

S. Shevtsov, I. Zhilyaev, P.A.Oganesyan, S.-H. Chang, V.-T. Cheng, P.-C. Wu. SIMULATION OF HELICOPTER VIBRATIONS BY SIMULINK DYNAMIC MODEL OF FULLY ARTICULATED ROTOR // Proc. of the Int. Conf. on Structural Engineering Dynamics - ICEDyn 2013 (17.6.2013 - 19.6.2013 Sesimbra, Portugal), 10 p.

S. SHEVTSOV, J.-K. WU, I. ZHILYAEV, J.-P. HUANG. Pareto-Based Approach to the Optimization of Schedule for the Polymeric Composite Structures Cure Process // Proc. of the 6th WSEAS World Congress: Applied Computing Conference - ACC 13 (Nanjing, China, November 17-19, 2013), pp. 46-53. http://www.wseas.us/e-library/conferences/2013/Nanjing/ACCIS/ACCIS-05.pdf

S.Shevtsov, I.Zhilyaev, M.Flek, L.Chinchan, V.Shevtsova. Distributed Model Based Thermal Control for Optimal Curing of the Large Composite Structures // Proc. of the 21st Mediterranean Conference on Control and Automation (June 25-28, 2013, Platanias-Chania, Crete, Greece), pp. 735-740.
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6608805&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6608805

Sergey N. Shevtsov, Igor V. Zhilyaev, Vladimir Akopyan, Michail B. Flek. CRACK IDENTIFICATION IN A BEAM-LIKE STRUCTURE USING THE PROBABILISTIC APPROACH AND TIMOSHENKO BEAM MODEL // Proc. of the 11th International Conference on Vibration Problems (Sept. 9-12, 2013, Lisbon, Portugal), 10 p.

S. Shevtsov, V. Kalinchuk, I. Zhilyaev, M. Flek, V. Akopyan, I. Samochenko. Dynamics of power high-stroke flextensional PZT actuator with optimized shell. Numerical and experimental study // 9th International Conference on Structural Dynamics, EURODYN 2014 (Porto, Portugal, 30 June - 2 July 2014), pp. 1631-1638 http://paginas.fe.up.pt/~eurodyn2014/CD/papers/229_MS09_ABS_1841.pdf

S.Shevtsov, I. Zhilyaev, L. Chinhan, M. Flek, A. Evlanov, C.-H. Liang, W.-C. Hsiao, J.-P. Wang, J.-K. Wu. Pareto-Based Optimization of the Cure Cycle at the Closed-Mould Forming of Thick Walled Polymeric Composite Structures // The 8th International Conference on Material Technologies and Modeling MMT-2014 (Ariel, Israel, July 28 – August 01, 2014), 10 p. http://www.ariel.ac.il/sites/conf/MMT/mmt-2014/service%20files/papers/1-119-129.pdf

J.-K. Wu, J.-P. Huang, S.N. Shevtsov, L.V. Chinchan Identification of Thermoset Resin Cure Kinetics Using DSC and Genetic Algorithm // Proc. of the Int. Conf. on Information Science, Electronics and Electrical Engineering ISEEE 2014 (April 26-28, 2014, Sapporo City, Hokkaido, Japan) pp.1204-1208. doi: 10.1109/InfoSEEE.2014.6947861 http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6947861

S.N. Shevtsov, V.V. Kalinchuk, S.-H. Chang, I.Zhilyaev, M. Shevtsova. MULTIOBJECTIVE PARETO-BASED OPTIMIZATION OF pMUT HYDROPHONE WITH PIEZOELECTRIC ACTIVE DIAPHRAGM // ASME 2014 12th Biennial Conference on Engineering Systems Design and Analysis ESDA2014 (June 25-27, 2014, Copenhagen, Denmark), 9 p. (doi:10.1115/ESDA2014-20281)
http://proceedings.asmedigitalcollection.asme.org/proceeding.aspx?articleid=1920112

Shevtsova M., Nasedkin A., Shevtsov S., Zhilyaev I., Chang S.-H. AN OPTIMAL DESIGN OF UNDERWATER PIEZOELECTRIC TRANSDUCERS OF NEW GENERATION // Proc. of the 23rd Int. Congress on Sound & Vibration, 8 p.

Sergey Shevtsov

Jiing-Kae Wu, Sergey N. Shevtsov, and Shun-Hsyung Chang Optimization of Two-Stages Cure Process Schedule for the Composite Structures of Open Shell Geometry // IEEExplore. Proc. of the IEEE International Conference on System Science and Engineering 7-9 July, Nantu, Taiwan, 5 p.

S. Shevtsov, M. Flek, I. Tarasov, K, Zhaivoronskaya. Multi-Objective Control Optimization for Curing the Shell-like Composite Structures // Proc. of the EngOpt 2016 – 5th International Conference on Engineering Optimization, Iguassu Falls, Brazil, (19-23 June 2016), 10 p.

Awards

1. Gold medal from X Moscow International Salon of Innovations and Investments (Sept. 7-10, 2010, Moscow, Gostiny Dvor) awarded Laboratory of Aircraft System and Technologies at the South Center of Russian Academy of Science (Head S.N. Shevtsov) for the development “Adaptive aircraft structures with intelligent control on the base of piezo-active smart materials”.
2. The scientific team of South Center of Russian Academy of Science awarded by the title of laureate on the base of results the competition “Aircraft Designer - 2011” from the Russian Confederation of Aircraft Manufacturer. Project “Mathematical Models and Software for "CAD / CAE Design - Simulation - Optimization" of Molding the Large High Loaded Aircraft Structures Made of Composite Materials” won 2nd place in the category “New Scientific Model of a Physical Phenomenon or Process”. (Project leader S. Shevtsov). December 2012
3. The scientific team S.Shevtsov, M.Flek, P.Oganesyan, I.Zhilyaev awarded by the title of laureate on the base of results the competition “Aircraft Designer - 2011” from the Russian Confederation of Aircraft Manufacturer. Project “Computer model for simulation the dynamics of a helicopter rotor” won 3rd place in the category “New Scientific Model of a Physical Phenomenon or Process”. December 2012

Research in progress

1. **Development of numerical and experimental methods for processing of optimal lay up and resin properties of glass- and carbon fibers reinforced plastics for high loaded composite structures experiencing an intensive environmental action, including**:

- the numerical (in particular, finite-element) methods to reconstruct the stress-strain state in the structure;
- the novel methods for optimization of the spatial distribution and orientation of the main anisotropy axes of orthotropic composite materials along the structure;
- based on the obtained data, optimal reinforcing scheme, which provides a desirable spatial distribution of elastic and strength properties of the composite, including a number and orientation of unidirectional layers of prepreg;
- the experimental methods and techniques of their numerical processing to determine the properties of the reinforcing fibers, viscoelstic and nonlinear elastic mechanical properties of the resins, their adhesion to the surface of the fibers in order to use these data in the behavior models of the composite construction with above-pointed reinforcing scheme;
- the novel method to determine the effective macro-characteristics of the composite considered as the continuous anisotropic material by using the numerical experiments with the representative volumes of the heterogeneous composite structures;
- the novel methods for numerical determination of the static, dynamic and strength (including fatigue strength) properties of the structure, considered as made from solid material with the given distribution of anisotropic properties by using the chosen and experimentally approved strength criterion;

- the methods of experimental verification of the developed optimization method for the composite structure by using a set of materials, samples and pieces of the constructions;
- the experimental methods to determine the degree of the mechanical and strength properties degradation for the processed composite constructions.

The comparative investigations by using a set of reinforcing fibers (GFRP and CFRP) and thermoset resins to determine the mechanisms of degradation, optimal choice of the properties of components and ranging the parameters of obtained materials.

2. **Development of the advanced multiobjective optimization method, and its application to the problem of optimum control synthesis at the cure of composite structure of complex shape using different schemes of cure equipment.**

Solving this problem requires the universal identification method to determine the type and parameters of the kinetic equation for the different kinds of thermoset resins using DSC, DMA technique, and also numerical processing software, methods of problem statement and numerical solving the coupled mechanical-thermal-kinetics equations of the curing process, computerized methods of multi-objective Pareto based process optimization, and the modern testing technique to estimate the short term and long term mechanical strength, dimensional stability and environmental resistance of composite parts.

3. Structural topology optimization for the light weight high loaded structures, including: lossless import of the preliminary designed CAD models of the parts to the finite element software;

formulation of static or dynamic mechanical problem for the optimized structures using known spatial distribution of the loads, their temporal characteristics, and constraints caused by the boundary conditions;

formulation of the objectives (one, two or more) and topological constraints dur to structural and technological restrictions;

choice of less consuming computational costs an optimization method;

smoothing of external shape of the part's model to eliminate the surface stress concentration;

development of reverse conversion of the optimized finite element model to CAE representation.

4. Optimization of power piezoelectric stacks' structural design and parameters of their electric load applied to the problem of piezoelectric energy harvesting.

This optimization problem is due to very big electric capacitance and relatively small mechanical stiffness of high power piezoelectric stack that can convert the energy of mechanical vibration or acting random mechanical forces to the electric energy. Such the problem is formulated differently for each particular cases of the mechanical energy source. Full information about these sources (force and displacement amplitudes, frequencies, gain etc.) allow to optimize the stack structure using available PZT and material of intermediate insulating layers. At the following step the lumped model of the stack should be constructed and identified. Our experience shows that most efficient tool for such the identification is the System Identification Toolbox MATLAB that receives input data from multiple simulation of the stack's finite element model. The last step is design of the electric load (including a battery, electric resistances, matching capacitance and electronics), description the coupled electric energy source / load by the system of integral / differential equations and formulating of optimal control problem, which solving gives the values of all electric components. The objective of this problem is maximum output electric power.