Ukrainian Aeronautics Research and Technology Groups Brochure

An initiative of the FP7 Aero-Ukraine project

SEVENTH FRAMEWORK PROGRAMME

This brochure has been prepared by the following group of experts for the **FP7 AERO-UKRAINE** project (www.aero-ukraine.eu):

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Preface

We would like to welcome you to the *Ukrainian Aeronautics Research and Technology Groups Brochure*.

Ukraine is one of the few countries in the world to have research, engineering and production capabilities across the complete range of aeronautics technologies. However, knowledge of its strength in aeronautics research and technology (R&T) remains comparatively low in Europe. Consequently, there exists a rich and timely opportunity for Ukrainian aeronautics organizations and their R&T activities to be presented collectively.

This brochure has been prepared under the FP7 AERO-UKRAINE project. The project is a European Commission funded initiative entitled "*Stimulating Ukraine - EU Aeronautics Research Cooperation*" (Contract No 233640). It aims to support the participation of Ukrainian aeronautics organizations in EU aeronautics research. The project runs from April 2009 until March 2011.

The specific objectives of the project include:

- Facilitate EU-Ukraine aeronautics research cooperation
- Map and report on Ukrainian aeronautics capabilities
- Organise FP7 aeronautics events in Ukraine
- Support Ukrainian participation in FP7-AAT programme
- Support preparations for a FP7 Aeronautics National Contact Point in Ukraine

The project is being implemented by a consortium of European and Ukrainian partners:

- SLOT Consulting, www.slotconsulting.hu, Project Coordinator
- Intelligentsia Consultants, www.intelligentsia-consultants.com
- University of Patras - Laboratory of Technology and Strength of Materials, www.mead.upatras.gr
- National Aerospace University of Ukraine (KhAI), www.khai.edu
- Frantsevich Institute for Problems of Material Science (IPMS-NASU), www.materials.kiev.ua
- SE Ivchenko-Progress, www.ivchenko-progress.com
- Antonov ASTC, www.antonov.com

If you would like further information about the FP7 AERO-UKRAINE project and its events, please visit our project website: www.aero-ukraine.eu

We hope you enjoy reading this brochure and it helps to strengthen future EU-Ukraine aeronautics research and technology collaboration.

Andrej Kocsis
Technical Coordinator

Roland Guraly
Co-chairman of the Project Management Team

Table of Contents

A.N. Podgorny Institute for Mechanical Engineering Problems of the National Academy of Sciences

Department of Non-Traditional Energy Technologies

Organisation Description

The A.N. Podgorny Institute for Mechanical Engineering Problems of the National Academy of Sciences of Ukraine (IPMash NAS) is a well known research centre in power and mechanical engineering. It belongs to the Physicotechnical Energetics Problems Branch of the National Academy of Sciences of Ukraine. 14 scientific departments are part of the Institute.

IPMash NAS is an active participant in the following activities: forming the energy strategy of Ukraine to 2030, and the concept of the State programme for ensuring technological safety in key branches of the economy; the regional programme “Resource”; the initiator of the Academic Scientific-and-Educational Complex (ASEC) for open-end training of researchers starting from school (academic lyceums) and through to post-graduate courses and Doctorate studies.

Research and Technology Development Activities

IPMash NAS’ key research areas are:

- optimisation of processes in power machinery, and improvement of equipment design;
- energy saving technologies and non-conventional power engineering facilities;
- predicting the reliability, dynamic strength and life of power equipment;
- simulation and computer technologies in power machine building.

IPMash NAS has major experience in numerical simulation of viscous flows in aerodynamic passages, taking into account three-dimensionality, compressibility, flow separation, unsteadiness, influence of turbulence and other physical effects.

IPMash NAS can produce new nonoxide powder materials using new milling equipment operating in liquid nitrogen (77K / -196 ^{0}C). When producing materials such as SiC, HfC, etc using cryogenic milling, the following physical and chemical properties can be obtained:

- chemical homogeneity of size composition;
- high dispersivity (up to 1 mkm);
- high purity;
- high physical and chemical activity;
- low sintering temperatures;
- high adhesion;
- no oxide layer at the surface;
- highly developed specific surface area;
- permanent properties during the long time period.

New structural carbon-ceramic material based on SiC demonstrates significantly improved strength and thermal physics characteristics compared to traditional materials. For example, gas turbine engine combustion chambers produced from these materials

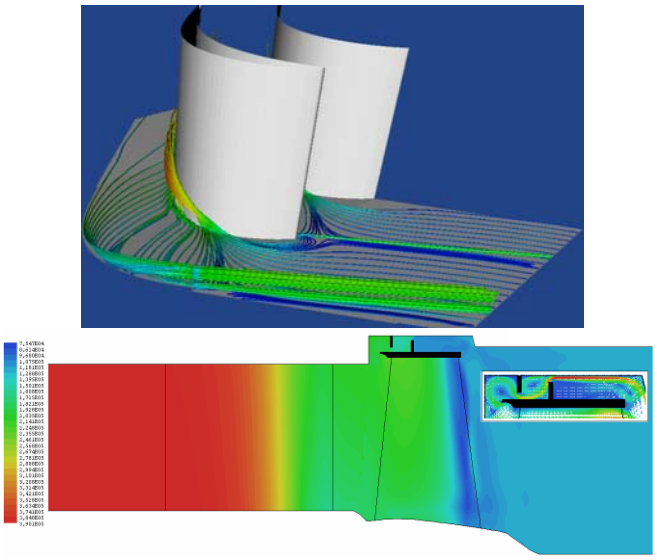

Fig. 1 3D analysis of flow around cascades

have ultimate bending strength, ultimate tensile strength and ultimate compressive strength that are two times higher. Also, their high-temperature strength and heat-resistance are significantly increased.

National and International Project Experience

National and international industrial projects include:

“OPTIMUM computer simulation system for solving multilevel conditional-unconditional scalar and vector optimisation as well as identifying parameters and characteristics of power installations for different applications” for SE “Ivchenko-Progress” (Ukraine), JSC "Nevsky Zavod" (Russia) and OJSC "Turboatom" (Ukraine).

“Mathematical simulation of turbo-machinery gas dynamic processes” involving Alstom Power (Poland), JSC “RPA Saturn” (Russia) and JSC “LMZ” (Russia)

“Analysing the oscillations and static strength of blading and other components of turbo machines” for turbine machine building enterprises in Ukraine and Russia as well as Skoda-Energo Ltd (Czech Republic).

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Antonov ASTC

Department of Aerodynamics

Organisation Description

Antonov ASTC was founded in 1946 by the famous aircraft designer Oleg Antonov. More than one hundred types and modifications of various aircraft classes and purposes have been designed since the company's foundation. The characteristic advantages of Antonov aircraft include structural reliability and economic efficiency, flexibility of transport operations, ability to use unpaved airfields and easy maintenance. Due to these qualities, over 1500 Antonov aircraft have been exported to more than 70 countries all over the world. All in all more than 22,000 aircraft have been built.

Nowadays, Antonov is engaged in designing and building new aircraft prototypes as well as modifications of earlier designs, the provision of operational and product support and engineering work on extending the service life of existing aircraft. Antonov also participates in international cooperation in the field of aircraft and equipment design and manufacture as well transit vehicle development.

Antonov's R&D facilities include:

- Design bureau and scientific laboratories for developing new aircraft and advanced research projects;
- Experimental production plant for building new flight test aircrafts and rebuilding serial Antonov aircraft;
- Flight-test facility for carrying out flight tests with new aircrafts.

Research and Technology Development Activities

The Department of Aerodynamics conducts the following R&D:

- aerodynamic configurations of new aircraft, new airfoils and wings, wing flaps, slats and other airlift devices;
- use of engine power to obtain high lift of the wing;
- complete cycle of experimental aerodynamic tests;
- simulators of engines;
- computational aerodynamics.

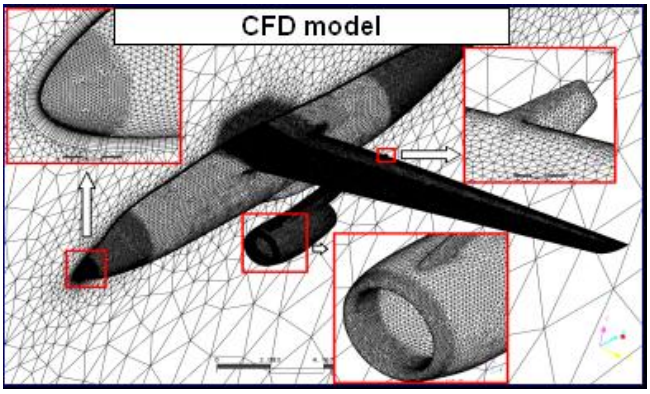

Fig. 1 CFD Model for the Antonov An-148

National and International Project Experience

The following are just some examples of Antonov's international collaborative projects:

1. Together with TsAGI (Russian Federation) – joint tunnel tests of aircraft models under high transonic speed.

2. Together with AVIC (China) – aerodynamics of the aircraft ARJ21, design of the aircraft Y8F600 and other projects.

3. Together with Thales and SAAB – prospective research works in avionics systems and mission systems of Antonov aircraft.

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Antonov ASTC
Department of Strength

Organisation Description

Antonov ASTC was founded in 1946 by the famous aircraft designer Oleg Antonov. More than one hundred types and modifications of various aircraft classes and purposes have been designed since the company's foundation. The characteristic advantages of Antonov aircraft include structural reliability and economic efficiency, flexibility of transport operations, ability to use unpaved airfields and easy maintenance. Due to these qualities, over 1500 Antonov aircraft have been exported to more than 70 countries all over the world. All in all more than 22,000 aircraft have been built.

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Antonov's R&D facilities include:

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- Experimental production plant for building new flight test aircrafts and rebuilding serial Antonov aircraft;
- Flight-test facility for carrying out flight tests with new aircrafts.

Research and Technology Development Activities

The Department of Strength conducts the following R&D:

- Static and fatigue strength tests from separate parts to complete aircraft;
- Development of methods based on IT;
- Research for prolongation of the service life of existing aircraft;
- Simulation of bird strike as a complex dynamic process;
- Development of surface hardening processes;
- Substantiation of structural reliability and durability;
- Methods and tools for inspection of the technical condition of structures.

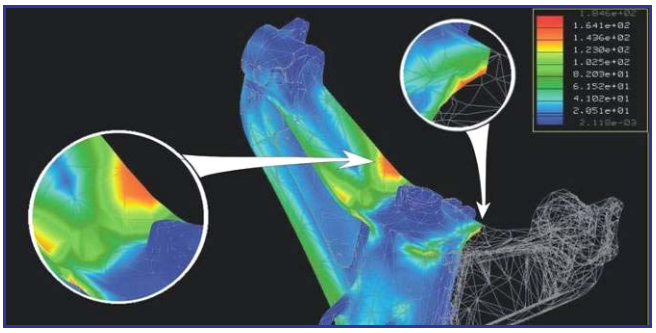

Fig. 1 Landing gear strength analysis

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Antonov ASTC

Department of Materials Science

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Antonov's R&D facilities include:

- Design bureau and scientific laboratories for developing new aircraft and advanced research projects;
- Experimental production plant for building new flight test aircrafts and rebuilding serial Antonov aircraft;
- Flight-test facility for carrying out flight tests with new aircrafts.

Research and Technology Development Activities

The Department of Materials Science conducts the following R&D:

- Constructions development and implementation;
- Nonmetal constructions based on carbon, glass, organic and hybrid fibres;
- Knitted lightning protection nets for polymer composites;
- Application of titanium alloys in aircraft.

Fig. 1 Engine nacelle of Antonov An-148 made of composite material

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Antonov ASTC
Department of Design

Organisation Description

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Research and Technology Development Activities

Antonov has invested heavily in computer-aided-design equipment and skills to support its aircraft design and development activities.

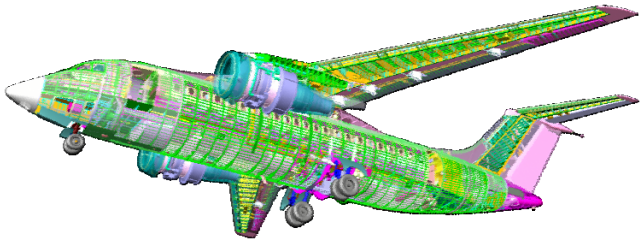

Fig. 1 CAD Model of Antonov An-148

National and International Project Experience

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Antonov ASTC

Department of Power Plants

Organisation Description

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Research and Technology Development Activities

Antonov works closely with SE Ivchenko-Progress on the development of aero-engines e.g.

- Two-row Counter-Rotated Propfans on An-70
- Long-term experience of Counter-Rotated Propellers on An-22

Fig. 1 Counter-rotated propellers on the Antonov An-22

National and International Project Experience

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Antonov ASTC
Department of Avionics

Organisation Description

Antonov ASTC was founded in 1946 by the famous aircraft designer Oleg Antonov. More than one hundred types and modifications of various aircraft classes and purposes have been designed since the company's foundation. The characteristic advantages of Antonov aircraft include structural reliability and economic efficiency, flexibility of transport operations, ability to use unpaved airfields and easy maintenance. Due to these qualities, over 1500 Antonov aircraft have been exported to more than 70 countries all over the world. All in all more than 22,000 aircraft have been built.

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- Flight-test facility for carrying out flight tests with new aircrafts.

Research and Technology Development Activities

Antonov's work over the years on "more electrical aircraft" includes:

- An-124 (1982) - world's first heavy transport airplane with a fly-by-wire control system
- An-70 (1994)– introduction of the electrical flap drive
- An-148 (2004) - world's first transport-category airplane with a 'more electrical' configuration of the control surface drive system achieved through the introduction of electric drives thereby saving 100kg airplane weight

Fig. 1 Antonov An-148 has a 'more electrical' configuration of the control surface drive system through the use of electric drives

National and International Project Experience

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A. Usikov Institute of Radio-Physics and Electronics of the National Academy of Sciences
Department of Diffraction Theory and Diffraction Electronics

Organisation Description

The A. Usikov Institute of Radio Physics and Electronics of the National Academy of Sciences of Ukraine (IRE NASU) was established in 1955 on the basis of the former Departments of Electromagnetic Oscillations and Radio Wave Propagation of the Kharkiv Institute of Physics and Technology of NASU. The main objective of the newly founded Institute was research and development in the wide frequency range of electromagnetic wave spectrum, with a special emphasis on the millimetre and sub-millimetre waves.

Since its establishment, the Institute has gained a status of a widely-known scientific centre, whose achievements determine the level of the national science in radio physics, vacuum electronics, quasi-optics, microwave studies in solid-state physics and biophysics, radio wave propagation, remote sensing of Earth from airborne and space-borne platforms.

Research and Technology Development Activities

Our R&D achievements include:

- fundamental theoretical and experimental analysis of the phenomena of electromagnetic wave generation;
- development of a series of new radiation sources operating in millimetre and sub-millimetre wavebands with wide potential for radar, communication systems, and defense applications;
- design of pulse-mode magnetrons whose operation mode is called the "Kharkiv 11", as well as continuous-mode magnetrons, klynotrons and reflection klystrons covering the wavelength range from 0.5 mm to 2 cm;
- design of new sources of coherent radiation of in mm and sub-mm ranges: orotrons (diffraction radiation sources) of pulsed and continuous modes having champion parameters in terms of high stability, narrow spectrum, low noise and high power;
- development of high-efficiency sources of far-infrared and optical band: dye lasers with a tunable frequency of induced emission;
- development of full sets of the waveguide measuring devices (within the range from 1 mm to 10 mm), a set of quasi-optical wide-range measuring devices and components for measurements within the wavelength range from 0.1 mm to 1 mm.

Also, we develop semiconductor radio location systems operating in the mm wavelength range. Such radio location systems can be used for aviation field vision, traffic control of aircrafts and transport facilities at airports.

Fig. 1 Millimetre wave semiconductor radar

Fig. 2 Klynotrons (O-type BWOs)

National and International Project Experience

R&D projects have been undertaken with numerous Ukrainian and international organisations. However, details of the projects are protected by confidentiality agreements.

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Chuiko Institute of Surface Chemistry of the National Academy of Sciences

Department of Nanochemistry of Functional Coatings

Organisation Description

Chuiko Institute of Surface Chemistry of the National Academy of Sciences of Ukraine was founded in 1986. The Institute carries out fundamental and applied research in the following areas:

- chemistry, physics and technology of surface;
- theory of chemical structure and reactivity of surface of solids, research into nature of active sites of surface, mechanisms of adsorption, chemical reactions, and transformations in surface layers;
- biomedical problems of surface;
- researches into surface states, diffusion phenomena, charge and mass transfer, phase formations in nanostructures, collective interaction in assemblies of particles, size-quantized effects of systems, interaction with radiation;
- technology of production of nanomaterials, highly disperse oxides, their modified forms, and composites on their basis.

The Institute runs the Kalush Experimental Plant (Ivano-Frankivsk region) to develop and produce nano-particulate metal oxide fillers and their modified forms.

Research and Technology Development Activities

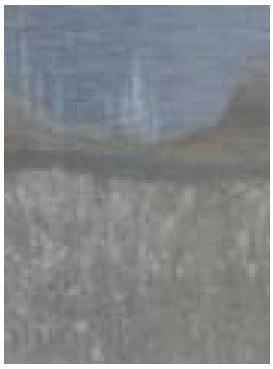
The Institute's RTD activities include:

- theory of chemical structure and reactivity of solid surface, research into the nature of active sites of surface, mechanism of adsorption, chemical reactions, and other transformations in a surface layer;
- biomedical and biochemical problems of surface chemistry, the interaction of disperse materials with bioactive molecules in supramolecular structures, with polymers, membranes and microorganisms;
- physical chemistry of surface phenomena, collective interaction in particle ensembles, quantum-dimensional effects in nanostructures, phase transitions in ultradisperse system, interaction of electromagnetic radiation with material;
- technology of production of nanomaterials, including those based on oxide and carbon systems, its modified forms and composites.

The Institute offers the following services:

1. Environment-friendly Cr(VI) free nanocoatings for corrosion protection of aluminium, magnesium and light alloys (Directive 2000/53/EC of the European Parliament and Council of 18/9/2000 on end-of-life vehicles);
2. Easy-to-clean and self-cleaning nanocoatings on the surface of metals and glass;
3. Nanostructured catalyst supports for ultra-deep cleaning of motor fuels (Directive 98/70/EC of the European Parliament and Council of 13/10/1998 relating to quality of petrol and diesel fuels and amending Council Directive 93/12/EEC).

Environmentally-friendly Cr(VI) free nanocoatings for corrosion protection of aluminium



Bare Al panel

Coated Al panel

Results of ASTM G-31 partial immersion testing (3.5 % NaCl at 40 ^{o}C, 7 day exposition) of 3003 H14 aluminium alloy (Type A test panels, Q–Panel Lab Products)

National and International Project Experience

European Commission projects: FP4 Project ("The development of catalysts for deep hydrodesulfurization of fuel for diesel engines", nanostructured catalyst supports, CIPDCT940510) and FP6 I-STONE ("Re-engineering of natural stone production chain through knowledge based processes, eco-innovation and new organisational paradigms", easy-to-clean superhydrophobic nanocoatings, NMP2-CT-2005-515762).

Swiss National Science Foundation project: "Surface engineering of nanostructural coatings on aluminium for environmentally friendly anticorrosion protection" (hexavalent chromium free anticorrosion nanocoatings, IB7320-111146).

INTAS Project: "Nanostructured catalysts for ultra-deep cleaning of motor fuels" (nanostructured catalyst supports, 00-00413).

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E.O.Paton Electric Welding Institute of the National Academy of Sciences

State-Run Company "International Center for Electron-Beam Technologies" (ICEBT)

Organisation Description

The International Center for Electron Beam Technologies (ICEBT) of the E.O.Paton Electric Welding Institute of the National Academy of Science of Ukraine was established in 1994 on the basis of a department conducting R&D in the field of electron beam physical vapour deposition (EB-PVD) technologies. It is a cost-effective R&D organization and independent legal entity with the right to provide contract research services to foreign state organizations and private companies.

ICEBT develops technology for high-rate EB-PVD of substances in vacuum. It uses the equipment to develop advanced materials and coatings with specific composition, structure and properties. These include amorphous and nano-crystalline materials with non-equilibrium structure (including carbon-based phases), dispersion-strengthened, microlaminated and microporous materials based on metals, alloys and ceramics (including graded nanostructured thermal barrier, hard erosion-resistant and damping coatings).

Research and Technology Development Activities

ICEBT has developed an EB-PVD system that enables the deposition of a multilayered graded nanostructured coating to be conducted in a single unit. It enables a major reduction in process time and cost as well as an improvement in the principal service properties of the coatings (thermal barrier, damping and erosion resistant).

For graded thermal-barrier coatings (graded TBC), the EB-PVD system can:

- reduce ceramic layer thermal conductivity to 0.6 W/mK;
- improve adhesion strength with bond coat (more than 150 MPa);
- increase thermal-cyclic life-time 2-2.5 times compared with traditional TBC.

For multilayered graded erosion-resistant and damping coatings of 25-45 microns thickness deposited at high deposition rate (up to 1 micron/min), the EB-PVD system can:

- increase 10-15 times the erosion resistance (compared to Ti-6-4 alloy) due to application of B4C-based layer, stable up to temperature up to 600 C;
- increase damping characteristics and absence of coating influence on fatigue limit of the substrate being protected;
- reduce the cost by half.

ICEBT offers clients EB-PVD equipment, patent licensing and know-how concerning:

- Graded thermal-barrier coatings NiAl/YSZ for hot section components of gas turbines
- Graded nanostructured erosion-resistant and damping coatings on steel & Ti alloy items.
- Manufacturing of EB-PVD units in accordance with customer requirements.

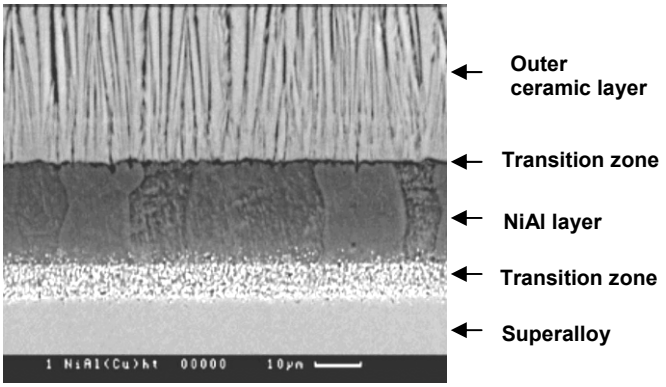

Fig. 1 Graded TBC with an YSZ outer ceramic layer

Fig. 2 Pilot-production EB-PVD unit

National and International Project Experience

STCU projects: P-084 "Low conductivity thermal barrier coatings (TBC) Development", P-108 "Deposition of TiN coatings onto flat panels and compressor blades using advanced EB-PVD process for Cametoid Limited", P-123 "Next Generation EB-PVD Multi Purpose machine", P-145 "Development of advanced graded erosion-resistant coatings and a new prototype of EB-PVD system for Cametoid Limited", and P-291 "Evaluation of the technology of electron beam deposition (EB-PVD) for production of inexpensive components of solid oxide fuel elements (SOFC)".

Private company projects: USA (General Electric, Pratt & Whitney, Chromalloy, Phygen), Canada (Cametoid), China (BAMTRI, BIAM, Xian Aero-Engine), Russia (Saturn), and India (ARCI).

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E.O. Paton Electric Welding Institute of the National Academy of Sciences
Department of Pressure Welding

Organisation Description

The E.O. Paton Electric Welding Institute (PEWI) is a multidisciplinary research institute which realizes fundamental and applied research works, develops technologies, materials, equipment and control systems, rational welded structures and weldments, methods and equipment for diagnostics and non-destructive quality control according to the following directions:

- Advanced technologies of welding and joining of materials;
- Strength, reliability and life of welded structures;
- Technology of surfacing, coating and treatment of surface;
- Processes of special electrometallurgy;
- New structural and functional materials;
- Technical diagnostics and non-destructive testing;
- Automation of processes of welding and related technologies.

The E.O. Paton Electric Welding Institute is a head organization of the Scientific-Technical Complex "The E.O. Paton Electric Welding Institute" of the National Academy of Sciences of Ukraine (STC PWI), which includes Design-Technological Bureau, Engineering Centres of high technologies, pilot workshops on explosion welding and treatment, and also a powerful production facility in the form of three pilot plants manufacturing welding equipment, consumables and using new technologies, which are capable to design, manufacture and deliver the pilot samples and batches of specialized equipment, welding and filler materials, welded structures and weldments.

Research and Technology Development Activities

The Pressure Welding Department conducts investigations into welding technology and equipment in the field of pressure welding, in particular:

- flash-butt welding;
- flash and resistance welding;
- friction and magnetically-impelled arc welding.

Also, investigations of physical-metallurgical processes in welding:

- steels, including carbon, stainless;
- alloys on the base of aluminium, titanium, nickel.

Our technology services include:

- Investigations of the formation of pressure welding joints in heat resistant alloys (wrought, cast, and PM);
- Pressure welding of titanium aluminides using thin nanolayered foils;
- Development of friction welding technologies of similar and dissimilar materials combination for aerospace industry.

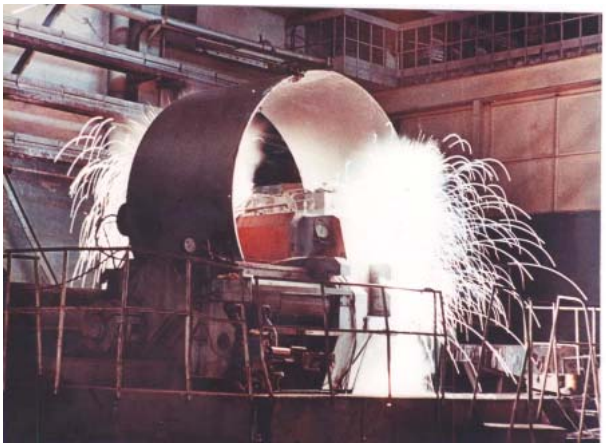

Fig. 1 and 2: Flash butt welding machines for joining of Al – based high-strength alloys used in aircraft and rocket engineering

National and International Project Experience

The Department has undertaken numerous R&D projects for the National Academy of Sciences of Ukraine. Also, the STCU funded project “Flash-Butt Welding; Technical Demonstration and Commercialisation”.

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E.O. Paton Electric Welding Institute of the National Academy of Sciences
Department of Optimization of Welded Constructions for New Equipment

Organisation Description

The E.O. Paton Electric Welding Institute (PEWI) is a multidisciplinary research institute which realizes fundamental and applied research works, develops technologies, materials, equipment and control systems, rational welded structures and weldments, methods and equipment for diagnostics and non-destructive quality control according to the following directions:

- Advanced technologies of welding and joining of materials;
- Strength, reliability and life of welded structures;
- Technology of surfacing, coating and treatment of surface;
- Processes of special electrometallurgy;
- New structural and functional materials;
- Technical diagnostics and non-destructive testing;
- Automation of processes of welding and related technologies.

Research and Technology Development Activities

The Department's activities focus on the optimization of welded thin-sheet stringer panels and cases from aluminium and titanium alloys for the construction of new generation, wide-body aircraft. The main aim of our investigations is to increase their operation life by regulating deformation and minimising welding heat by means of ray and arc techniques and also by friction welding with mixing. We have developed technologies and equipment for non-deformation welding of stringer panels from BT-1 and AMg6 alloys with the length up to 2.5m and cases from AMg5 and AMg6 alloys with diameter 0.5 – 4.0m.

On the base of holography and speckle interferometry, we have developed methods of non-destructive defectoscopy and diagnostics of stressed state of thin-sheet aviation constructions from the aluminium, titanium alloys and composites. We have also developed unique technology to increase the operation life of intermediate cases of aviation engines from Mg alloys by means of welding exploitation defects under the influence of gradient heat fields.

We have developed a method of fatiguing effect deceleration by means of electrodynamic treatment of crack top by electric current impulses in the local field of compression stresses. This method helps to increase the operation life of aircraft where cracks of undercritical length have appeared. The equipment used for this method is compact and easy to use. Consequently, this method may be used on aircraft parked in an airport and there is no need to send the aircraft to a repair centre.

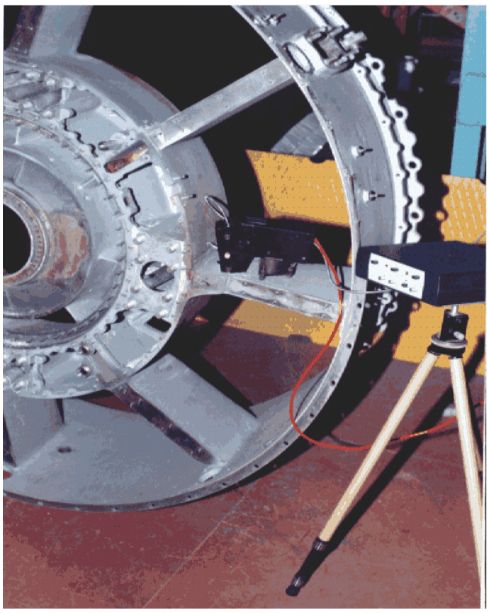

Fig. 1 Determination of residual stresses using speckle-interferometry method in the assembly of fastening an aircraft engine (material – magnesium alloy)

National and International Project Experience

Private company projects: Airbus Aerospatiale (France) and Plant STOLITSA (Korea).

STCU project: "Modern methods of welding and production of the constructions from aluminium and lithium alloys" with Boeing (USA)

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences
Department of Composite Materials

Organisation Description

The Frantsevich Institute for Problems in Materials Science (IPMS) is Ukraine's leading research centre in the field of material science and advanced technology of metal, ceramic and composite materials. IPMS provides advanced scientific and engineering consultancy as well as contract research and development services.

IPMS was set up in 1955 on the base of the laboratory for special alloys of the Ukrainian Academy of Sciences. Since then it has progressively widened its fields of research and customer base. IPMS' activities in new material development and commercial application are supported by a large pool of researchers in solid-state physics and chemistry, inorganic physical chemistry, and mechanics of deformable media.

IPMS employs about 1700 people, including 70 doctors and more than 345 PhD. IPMS is a large scientific and research complex, including Special Design Bureau with Pilot Plants, Computer Centre and Laboratory for Basalt Materials Production.

Research and Technology Development Activities

The Dept of Composite Materials is currently studying wire knitted meshes and nanostructured carbon fillers for lighting protection and repair of carbon plastics. The aim is to develop a fabrication technology for elements of polymer fibrous composites with a surface reinforced by flexible copper meshes, consisting of thin wires, covered with low-melting solder.

The copper meshes can dissipate the energy of a thunderbolt through the effective power- and heat sink from the zone of lighting strike. In the global aircraft construction (Boeing, Airbus and others), the problem of lighting protection of carbon-plastics is very acute. Generally, it has been solved by the use of stretchable perforated copper foil.

The important advantages of the IPMS approach are that the knitted copper meshes have i) a low weight (up to 40% compared with tensile foils) and ii) an enhanced ability to dissipate energy due to the unsoldering of flexible loops, evaporation of solder from wires surface and relaxation of mechanical stresses in the surface layers of composites.

Also, it has been established that the conductivity of polymer composite surface layers have been significantly enhanced by means of nanostructured carbon fillers. Discharge test of experimental panels showed that both meshes and fillers contribute to the improvement of lighting durability of elements of aviation structures.

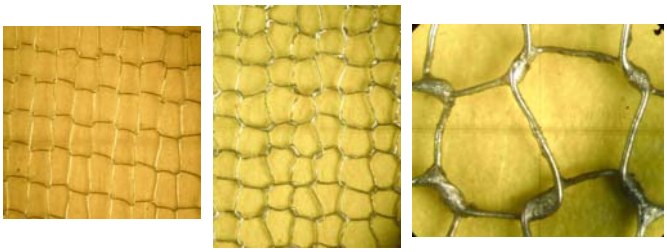

Fig. 1 Wire knitted meshes and nanostructured carbon fillers for lighting protection and repair of carbon plastics

National and International Project Experience

IPMS is working with Antonov to develop knitted lightning protection meshes for composite parts.

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences
Department of Composite Materials

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Research and Technology Development Activities

The Dept of Composite Materials is working with Antonov ASTC to develop antifriction products for aviation constructions. Antifriction composite materials (so called metal fluoroplastics) have been developed with a steel matrix with the porous layer of sphere bronze particles and with pores filled by fluoroplastic with antifriction additives of molybdenum disulfide.

To improve strength, corrosion resistance and the operating life of aviation components, composites have been made with steel, titanium and aluminium alloys. Also, a technology process for producing complex friction surfaces has been developed. The process simplifies the detailed construction thereby ensuring the friction processes and performance without additional lubricants.

The interval of operating temperature for machining screws is from -60 ^{0}C up to + 250 ^{0}C at sliding velocities up to 1 m/s and bearing capacity up to 100 MPa.

Fig. 1 Machining screw with metal fluoroplastic layer with rectangular thread

Fig. 2 Compensator detail with antifrictional polymeric coating at the operational surface

National and International Project Experience

IPMS works closely with Antonov ASTC.

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences

Department of Contact Phenomenon and Non-metal Materials Brazing

Organisation Description

The Frantsevich Institute for Problems in Materials Science (IPMS) is Ukraine's leading research centre in the field of material science and advanced technology of metal, ceramic and composite materials. IPMS provides advanced scientific and engineering consultancy as well as contract research and development services.

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Research and Technology Development Activities

The Department of Contact Phenomenon and Non-metal Materials Brazing investigates the phenomena of welding and soldering of inorganic materials: ceramics, oxides, nitrides, quartz glasses, glass ceramics, carbon reinforced materials and special functional materials (segneto- and piezoelectric materials, infra-transparent materials, etc). Special metallic soldering melts (adhesion–active solders), which can wet non-metallic materials, have been developed for such purposes.

The Department has developed methods of soldering lens and discs from optically transparent leucosapphire for use in gas-turbine engine applications (temperatures up to 650 °C and pressures up to 2.5 MPa). To measure the temperature of gas turbine engine blades, an optical pyrometer sensor is often used. The pyrometer sensor is mounted on the turbine case. In the sensor case there is an optically transparent window with a 8-12 mm diameter.

The Department has experience of soldering leucosapphire to the metal case. Earlier similar works had been performed in cooperation with Ufa engine consortium. Furthermore, we have an experience in soldering quartz glass windows (10-500 mm diameter) with high optical properties for aviation and space devices.

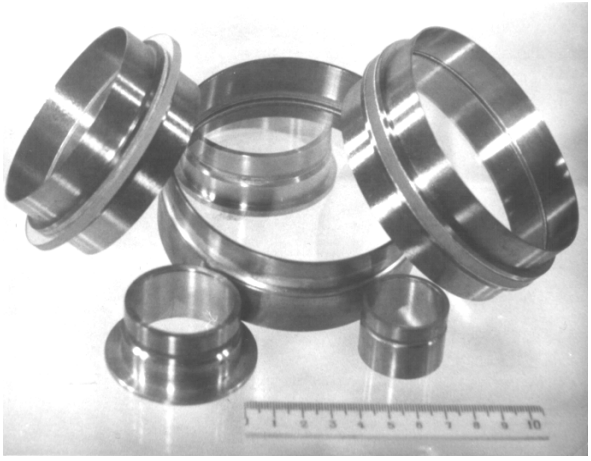

Fig. 1 Soldered and welded under pressure optical high-vacuum titanium-sapphire windows

National and International Project Experience

IPMS collaborates with companies from the U.S.A., United Kingdom, France, Germany, Yugoslavia, Poland, Hungary, Bulgaria, Austria, Switzerland, Mexico, India, Cuba, South Korea, Israel, Japan and China. IPMS has carried out around 100 international projects during the past 7 years.

IPMS sells licenses to use its advanced technology as well as sets up Joint Ventures to produce cutting tools, wear and corrosion resistant coatings using detonation spraying technique, ceramics for electrical application, and ceramic powders of high purity.

IPMS has set up service centres to support detonation coating technology in Japan, China, Yugoslavia and Iran.

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences

Department of Fine Inorganic Synthesis, Thermodynamics and Kinetics of Heterophase Processes

Organisation Description

The Frantsevich Institute for Problems in Materials Science (IPMS) is Ukraine's leading research centre in the field of material science and advanced technology of metal, ceramic and composite materials. IPMS provides advanced scientific and engineering consultancy as well as contract research and development services.

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Research and Technology Development Activities

The Dept is involved in the development of nanotechnologies and nanochemistry for layered transition metals dichalcogenides (2H-MCh_2, M=Mo, W; Ch=S, Se). It has conducted studies of the structure-sensitive tribological properties of 2H-MCh_2 layered nanostructures and solid nanolubricants design.

Layered transition metals dichalcogenides (2H-MCh_2 (M=Mo, W; Ch=S, Se) are efficient solid lubricants which have low friction coefficients and the ability to operate in space or vacuum conditions. The application fields of d-transition metals dichalcogenides as solid lubricants can be significantly expanded by use of their layered nanostructures with structure-sensitive tribological properties on solid nanolubricants design. In particular, for new effective solid nanolubricant additives to oils and greasers, in order to substantially improve their operational properties.

Nanotechnologies for layered 2H-MCh_2 nanostructures have been developed. The nanotechnologies enable to prepare homogeneous 2H-MCh_2 layered nanostructures (ultra-thin nanoshhets, inorganic graphen-like nanoparticles) with extremely small sizes (~ 1 nm) of anisotropic nanoparticles.

The nanocrystalline 2H-MoS_2, 2H-WS_2 has been used as a solid nanolubricant additive to industrial oil to improve significantly its tribotechnical characteristics, in comparison to the application of micron powders of natural molybdenum disulfide. There are significant decreases of friction force (in 1.5 times) and an increase in the durability (in 1.5–2 times). Meanwhile, laboratory and bench-top test results for benthonitic lubricants with nanocrystalline 2H-MoS_2 additions show good prospects for tribotechnical systems design which are operating at high temperatures (260–490 K) and loadings and also moderate speeds (aero-space engineering and others).

Fig. 1 Frantsevich Institute for Problems in Materials Science (IPMS)

National and International Project Experience

National Projects:

1) Complex program of fundamental investigations of National Academy of Science of Ukraine (NASU) "Nanostructured systems, nanomaterials and nanotechnologies" (2004-0009).

International Projects:

1) COST (European Cooperation in Science and Technology) Action 532: TS5 "Advanced nanostructured materials on the based of intercalated systems – layered transition metal dichalcogenides (TMD) using in high-tech lubricant design" (2003–2007).

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences

Department of Physics of High-Strength and Metastable Alloys

Organisation Description

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Research and Technology Development Activities

The Dept's work in the field of phase transformations is the physical base for the creation of new cast aluminium alloys which, according to their physical and mechanical properties, exceed modern cast high strength aluminium alloys. The new cast alloys are created on a basis of the quasibinary (α-Al+Mg_2Si) section of the ternary system Al-Mg-Si(X). The two groups of alloys have been developed: for operating at ambient temperature (Type I and Type II) and for high-temperature application (Type III).

Alloy	Testing tempature, °C	Mechanical properties			Melting interval, °C
		UTS, MPa	YS, MPa	δ, %	
Type I	20	540- 660	490-620	1-2	590-620
Type II	20	310- 501	300-460	<1	575-590
Type III	20	240-330	225-275	<1.5	595-599
	260	180-203	146-164	5-10	
	315	102-130	91-115	13-15	

The essential advantages of the new alloys are the combination of high mechanical, tribology, corrosive properties and excellent castability. The yield strength of new cast eutectic alloys exceeds this characteristic for available cast aluminium alloy 356.0 (USA) in all temperature test intervals. The new (α-Al+Mg_2Si) alloys could be potential candidates for replacing certain commercial alloys. These alloy compositions have been patented.

The Dept has equipment for melting high quality ingots up to 20 kg from aluminium alloys. Also, the following equipment for thermal treatment and testing:

1) Mechanical test in a temperature interval from −196 to +1400 °C;
2) Indentation testing from −196 to +1000 °C;
3) TEM, SEM, Auger spectroscopy, light microscopy;
4) High-temperature (up to 2200 °C) DTA unit;
5) Units for investigation of tribological characteristics.

Fig. 1 Complex for tribotechnical investigations

National and International Project Experience

National Projects:

2) Theme # III-17-05 of the Ministry of Science and education of Ukraine "Development of deforming and cast aluminum alloys with enhanced level of mechanical properties"

International Projects:

2) COST 532 project code: ES5 (M4) "Elaboration of novel eutectic alloys on the base of Al-Mg-Si system for tribotechnical application in cylinder-piston groups at elevated temperatures", 2003-2007;
3) STCU project # 3605 "New light-weight composites on the base of cubic aluminium intermetallides $L1_2$ with enhanced heat resistance", 2006-2008;
4) STCU project # P061 "Structure and properties of high-strength alloys of aluminum", 2000-2003.

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences

Department of Physical Materials Science and Solid State Physics

Organisation Description

The Frantsevich Institute for Problems in Materials Science (IPMS) is Ukraine's leading research centre in the field of material science and advanced technology of metal, ceramic and composite materials. IPMS provides advanced scientific and engineering consultancy as well as contract research and development services.

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Research and Technology Development Activities

The Institute's RTD activities include:

- Investigating dispersion- and eutectic-strengthened structural materials (metallic, ceramics, ceramic metals) aimed at exploration of relation of material structural parameters with mechanical properties;
- Creating a scientific basis for elaborating silicon-boride-strengthened Ti-based materials possessing increased values of Young modulus and high-temperature strength;
- Studying effects of alloying, solidification rate, thermomechanical processing and boron addition technique on structure and mechanical properties of Ti-Si-X, Ti-B-X, Ti-B-Si-X (X = Al, Zr, Sn) alloys;
- Studying phase equilibria in the Ti-Si-X, Ti-B-X, Ti-B-Si-X systems including detailed investigation of "titanium corners" of the diagrams aimed at an increase of both heat resistance and plasticity;
- Studying effect of solidification processing rate at cooling rate 10^2 - 10^7 °/s on formation of boride phase and its eutectic constituents, their morphology and geometrical parameters in alloys of Ti-Si-X, Ti-B-X and Ti-B-Si-X systems, using different technological procedures of alloy crystallization.

The Institute offers the following services:

- Production of rapidly solidified powders, their compacting and thermo-mechanical processing;
- Elaboration of silicon-strengthened titanium "steels" possessing increased high-temperature strength, oxidation resistance and ductility;
- Elaboration of advanced in situ reinforced Ti-matrix composites;

Fig. 1 Transmission components made from novel titanium composites (tribotic)

- Optimization of alloy composition with respect to main (Al, Si, Zr) and other alloying additions;
- Development and manufacturing of advanced biomaterials on the basis of titanium alloys such as femoral heads for hip joints;
- Thermomechanical processing and powder metallurgy technology with high solidification rate in manufacturing Ti-based alloys to exert effect on formation, geometry and morphology of boride phase;
- Combination of powder metallurgy methods with different boron addition techniques allowing a number of problems taking place in traditional manufacturing such alloys to be solved.

National and International Project Experience

Ukrainian Ministry of Science and Education project: "Development and manufacturing titanium based femoral heads for hip joints" (N 0106U006699)

STCU projects: P-1847 "Structure and properties of eutectically reinforced materials based on titanium intermetallics and silicides" (IMAP, USA) and P-060 "The study of structure formation and mechanical behaviour of heat-resistant titanium alloys with eutectic strengthening" (EOARD, Air Force Research Laboratory, USA)

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences

Department of Physics of Strength & Plasticity of Materials

Organisation Description

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Research and Technology Development Activities

Structural and high-temperature resistant Ti-based intermetallic compounds (Ti_3Al, Ti_2AlNb and TiAl) are considered as the most perspective alloys for further progress in aero engine applications. The Department has developed as-cast alloys with high Nb content that have unique high temperature properties for Ti-Al system alloys. The yield point at 800 ^{o}C is of 1000-1200 MPa and softening appears at 900 ^{o}C. The room temperature ductility under compression is 10-15 %.

The Department is also investigating complex alloyed TiAl-based materials by Sc, rare earth metals (like Gd, Y, Nd, Dy) and B during melting process in order to improve their mechanical properties. Ingots produced from the developed alloys will be used as starting materials (cathodes) for vacuum arc evaporation with a subsequent deposition of plasma flow onto metal substrates in order to obtain intermetallics-based functional coatings. The vacuum arc deposits made of γ-TiAl alloys differ from as-cast materials of the same composition due to their more fine-grained structure and higher hardness. They allow modification of the surface of critical cast parts and produce graded structures with an increased operational capability. The new TiAl-based alloys and coatings are being considered for use on LP turbine blades, HP/IP compressor blades, engine casing and stators.

The Department's facilities include:

- Melting laboratory units
- Modified "Bulat-3T" coater for vacuum-arc evaporation
- Differential thermal analysis (DTA) installations
- X-ray diffraction technique
- Machines for mechanical tests of materials (T range: -196-800 ^{o}C and loading rates range: 10^{-5} – 10^{-1} s^{-1})
- Hot long term hardness tester UGT-2
- Vickers, Rockwell, Brynell hardness and microhardness testers
- Set of optical, electron microscopes and microanalysers
- Automatic indentation unit ("Micron-Gamma")

Fig. 1 BT-6-based brake disk with Tribotic frictional lining

National and International Project Experience

National Academy of Science projects: "Structure and phase transformations in Ti-Si-X and Ti-B-X systems and their influence on physico-mechanical properties of materials" (2005-2008); "Reinforcement of titanium alloys by intermetallics with Ti_3X and TiX types of additionally alloyed with aim of their softening" (2006-2009); "Phase diagrams and thermodynamics of multicomponent systems as physico-chemical background for elaboration of modern alloys with peculiar properties: light hard on the basis of complex borides, amorphous, quasicrystalline, high-temperature titanium, with shape memory effect" (2006-2009); and "Optimization of compositions and structure of high temperature titanium aluminides based alloys and coatings with enhanced low temperature properties" (2010-2014).

STCU projects: RP-1847 "Structure and properties of eutectically reinforced materials based on titanium intermetallics and silicides" (2003-2004); P321 "Design and Modelling of new multicomponent materials based on the system Titanium-Silicon. Nanostructuration and properties" (2007-2008); RP-3382 "New eutectic titanium alloys reinforced by high dispersed silicide-boride or germinide-boride phases" (2007-2009); and RP-3605 "New light eutectic alloys for coating based on cubic $L1_2$ aluminum intermetallics with enhanced level of heat- resistance" (2007-2008).

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Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences

Department of Solar Engineering and High Temperature Thermophysics

Organisation Description

The Frantsevich Institute for Problems in Materials Science (IPMS) is Ukraine's leading research centre in the field of material science and advanced technology of metal, ceramic and composite materials. IPMS provides advanced scientific and engineering consultancy as well as contract research and development services.

IPMS was set up in 1955 on the base of the laboratory for special alloys of the Ukrainian Academy of Sciences. Since then it has progressively widened its fields of research and customer base. IPMS' activities in new material development and commercial application are supported by a large pool of researchers in solid-state physics and chemistry, inorganic physical chemistry, and mechanics of deformable media.

Research and Technology Development Activities

The Department's R&T activities are focused on:

- Investigation and production of various materials and coatings using radiation heating;
- Study of heat-protective and thermophysical characteristics of materials via modeling of radiation convective heating under conditions of orbital flights or aerocapture of descending vehicles and space planes (Discovery Diploma RAEN №298 from 15.12. 2005);
- Life tests and determination of heat conductivity of heat-protecting materials;
- Development of equipment and technologies for deposition of high-temperature corrosion-resistant coatings using high-speed gas-flame spraying.

The Department's main technologies and services are:

- Solar stations with a mirror of 1 to 5 m diameter and radiation heating units on the basis of xenon lamps with a heat flow density of to 15 000 kWt/m^2;
- Burners with control of flow characteristics for high-rate gas-flame deposition of coatings (Fig.1);
- Plasmatrons and gas generators for investigation of heat protecting materials;
- Computerized installation for measuring heat conductivity of low-heat-conductivity materials and honeycomb construction of spaceships.

Fig. 1 Two-chamber burner with control of flow characteristics for high-rate gas-flame deposition of coatings

National and International Project Experience

The Department has conducted numerous projects for the Ministry of Science and Education, National Academy of Sciences and industry.

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G. S. Pisarenko Institute for Problems of Strength of the National Academy of Sciences

Department of Materials and Structures Strength at Low Temperatures

Organisation Description

The G.S. Pisarenko Institute for Problems of Strength of the National Academy of Sciences of Ukraine (IPS NAS) was founded in 1966 on the basis of the Department of Strength of the Institute for Problems of Material Science of the Academy of Sciences of Ukraine.

In recent years, some changes have taken place in practical aspects of the investigations performed at the Institute. Earlier, research efforts were concentrated on investigations aimed at scientific and technical accompaniment of novel structures in rocket, aerospace, and propulsion engineering, whereas nowadays their main concern is with the evaluation of the remaining life and justification of the possibility of further safe operation of equipment in nuclear and thermal power engineering, main oil-, gas-, and product pipelines, aeronautic apparatus, oil-refining and chemical industries, railway transport, etc.

Research and Technology Development Activities

IPS NAS is mainly involved in the following research:

- ultimate state and strength criteria of structural elements of power, transport, and aerospace engineering, and thermal and nuclear power engineering, which operate under extreme conditions;
- studying the integrity and survivability of materials and structures with crack-like defects under static and cyclic thermomechanical loading, as well as reliability of mechanical systems under conditions of vibration;
- devising methods for the calculation and investigation of the stress-strain state of structural elements taking into account the influence of manufacturing, service, and other factors accompanying their operation;
- examination of the technical conditions of structures in operation by non-destructive methods and elaboration of calculation and instrumental methods for determining their remaining life at the stages of development of non-localized and localized damages.

IPS NAS provides the following technology services:

- High and low cycle fatigue calculation for aircraft structures with concentrations under non-regular cycle loading with take into account non-proportional strain hardening of the materials;
- Development of non-linear fatigue damages accumulation rule for random cycle loading and real fly loading spectrum.

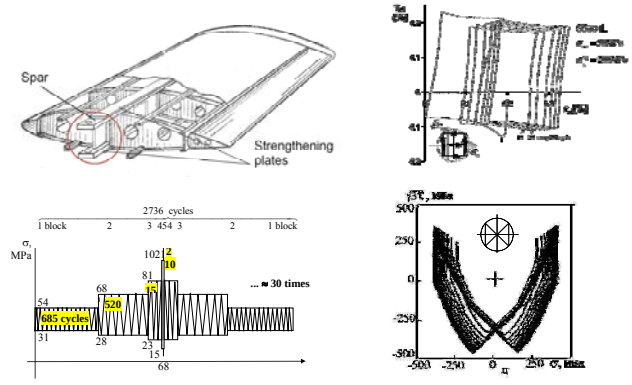

Fig. 1 Modelling the complex non-regular cyclic loading with taking into account cyclic hardening and ratcheting

National and International Project Experience

National industrial projects:

- "Development of methods and software on reliability increasing of the piping from austenite steels" (Chernobyl NPP, Ukraine)
- "Elastic-plastic behaviour of structures materials under small strain and low temperatures" (National Academy of Sciences of Ukraine, Contract N 1.3.4.220)
- "Transmission pipelines with defects residual strength determination" (Nat. Joint Stock Company "NAFTOGAS of Ukraine", Ukraine National Standard DSTU-N B V.2.3-21:2008)

European Commission funded projects:

- "Lifetime management software for transit oil and gas pipeline (LIMATOG)" (ERBIC 15 CT 96-0715)
- "Tacis – Inogate Project: Supply for safety and security of main gas transit infrastructure in eastern Europe and the Caucasus" (EuropeAid/126297/C/SUP/Multi, Contract N 2008/141-397)

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G. S. Pisarenko Institute for Problems of Strength of the National Academy of Sciences
Department of Numerical and Experimental Studies of Structural Integrity

Organisation Description

The G.S. Pisarenko Institute for Problems of Strength of the National Academy of Sciences of Ukraine (IPS NAS) was founded in 1966 on the basis of the Department of Strength of the Institute for Problems of Material Science of the Academy of Sciences of Ukraine.

In recent years, some changes have taken place in practical aspects of the investigations performed at the Institute. Earlier, research efforts were concentrated on investigations aimed at scientific and technical accompaniment of novel structures in rocket, aerospace, and propulsion engineering, whereas nowadays their main concern is with the evaluation of the remaining life and justification of the possibility of further safe operation of equipment in nuclear and thermal power engineering, main oil-, gas-, and product pipelines, aeronautic apparatus, oil-refining and chemical industries, railway transport, etc.

Research and Technology Development Activities

The department as been conducting research for many years towards the development of a general concept of Mode I fracture under biaxial loading in tension and/or compression.

It is of scientific and practical interest to develop a general fracture criterion and a test method such that the nucleation and extension of a single tear crack in damage-tolerant components made from metallic, non-metallic or composite materials could be assessed in a unified manner.

To establish the basic principles of this concept, called the Unified Methodology (UM) of fracture investigation, we performed an extensive experimental study of stable crack growth in brittle and ductile materials. Focus was on the fracture behaviour of a single through crack in plates and tubes subjected to monotonic loading in tension and compression. Specimens of different geometries and sizes were made from notionally homogeneous metallic and non-metallic materials with widely varying properties.

The overall objective of the UM development is to formulate a transferring law, i.e., a common function for experimental data on stable crack growth in simple specimens of a relatively small size and large-scale components of complicated geometry. This function can be seen as a key result of the coordinated research efforts towards developing an advanced, coherent, and harmonised fitness-for-service procedure for a through-life assessment of tearing in thin-walled components made from sheet materials of any physical nature. Because of the breadth of this research programme, the UM concept remains at the development stage and the related exploratory studies are still in progress.

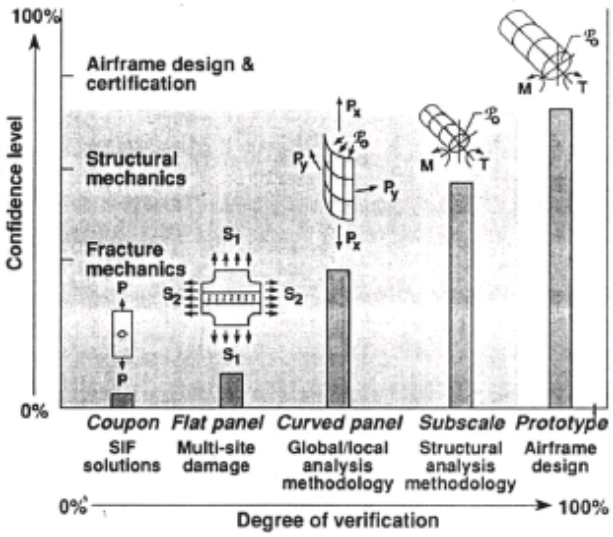

Fig. 1 Failure prediction methodology

National and International Project Experience

National industrial projects:

”Development of the Express-Method for Tensile Fracture Testing of Thin-Sheet Metals” (Antonov)

INTAS funded projects:

“The Transferability of Mode I Crack Growth Resistance Curves” (INTAS-94-0722) and “Assessment of Cracks in Large-Scale Plates and Shells under Biaxial Loading”

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G. S. Pisarenko Institute for Problems of Strength of the National Academy of Sciences
Department of Fatigue and Thermal Fatigue of Materials

Organisation Description

The G.S. Pisarenko Institute for Problems of Strength of the National Academy of Sciences of Ukraine (IPS NAS) was founded in 1966 on the basis of the Department of Strength of the Institute for Problems of Material Science of the Academy of Sciences of Ukraine.

In recent years, some changes have taken place in practical aspects of the investigations performed at the Institute. Earlier, research efforts were concentrated on investigations aimed at scientific and technical accompaniment of novel structures in rocket, aerospace, and propulsion engineering, whereas nowadays their main concern is with the evaluation of the remaining life and justification of the possibility of further safe operation of equipment in nuclear and thermal power engineering, main oil-, gas-, and product pipelines, aeronautic apparatus, oil-refining and chemical industries, railway transport, etc.

Research and Technology Development Activities

IPS NAS is mainly involved in the following research:

- the ultimate state and strength criteria of materials and structures;
- calculation-and-experimental methods for investigating the stress-strain state;
- fracture mechanics and survivability of structures;
- vibrations of non-conservative mechanical systems.

In particular, our department is involved in the estimation of lifetime of materials under fretting fatigue taking into consideration interference of electrical phenomena and complex stress state in the zone of contact and friction. Our work research and development in this area is employed for materials and coatings used in aircraft constructions and aero-engines.

Methods of estimation of fatigue lifetime under conditions of fretting published so far allow one to consider the majority of factors accompanying fretting fatigue: the complex stress state, fretting wear, plasticity, out-of-phase loading, a configuration of contact, change of a friction coefficient during cycling, presence of zones of slip and stick in contact, etc.

However, the question of interference of the nature of contacting materials is poorly explored. At the same time observable processes of electric currents flow through contact and accumulation of electrical potential testify that these parameters can be either accompanying fracture, or only reflecting intensity of processes, that can be considered in computational methods for lifetime, also for an estimation of influence of the nature of materials on their compatibility under fretting. These are areas that our department has specialist knowledge and experience.

Table 1. Data on the currents at steady stage and relative fretting fatigue limit

Coating	Current, μA	Relative fretting fatigue limit
VAP-2	7	0.447
Low - temperature cyanidation	10	0.34
Brass (galv)	12	0.328
TiN + Copper	14	0.29

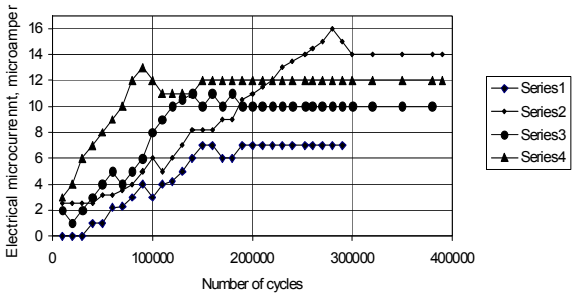

Fig. 1 Evolution of electrical microcurrents in the course of fretting fatigue loading of titanium alloys with coatings: (1) VAP-2, (2) low-temperature cyanidation, (3) brass (galv) and (4) TiN +copper

National and International Project Experience

National industrial projects:

"Effect of various surface modifications and coatings on fretting fatigue of titanium alloys for dovetail joints" (JSC "Motor Sich", Zaporozhye)

Internationally funded projects:

"Investigation in fretting fatigue of materials" (Sheffield Hallam University - School of Engineering, UK grant)

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Institute of Engineering Thermophysics of the National Academy of Sciences
Department of Thermogasdynamics

Organisation Description

The Department of Thermogasdynamics is the leading Ukrainian research group on gas turbine blade cooling. The department's scientific interests include swirling and vortex flow fundamentals, air-cooled gas turbine blades, heat transfer augmentation, internal blade cyclone cooling, novel oscillating film cooling, and high temperature heat exchangers.

The department has 25 staff including 12 PhD research associates, engineers and technicians. The department has close scientific links with Cardiff University (UK), CHAM Ltd (UK), U.S. Air Force Academy, University of Minnesota (USA) and University of Utah (USA). Staff members have made many international visits to deliver lectures and presentations.

Over the past fifteen years the staff members have published 10 books and 202 journal papers. Their research was supported through grants from the Royal Society (UK), NATO Scientific Committee, National Research Council (USA) and others. The head of department - Professor A. Khalatov - is a winner of the first NATO Scientific Committee Prize (2002) and has been awarded the Yu. A. Gagarin medal of the Russian Space Agency.

Research and Technology Development Activities

The department scientific interests include:

(i) swirling and vortex flows fundamentals,
(ii) air-cooled gas turbine blades,
(iii) heat transfer augmentation,
(iv) internal blade cyclone cooling,
(v) novel external oscillating film cooling,
(vi) high temperature heat exchangers.

The department has developed the following new cooling technologies:

(i) internal blade cyclone cooling,
(ii) external oscillating film cooling.

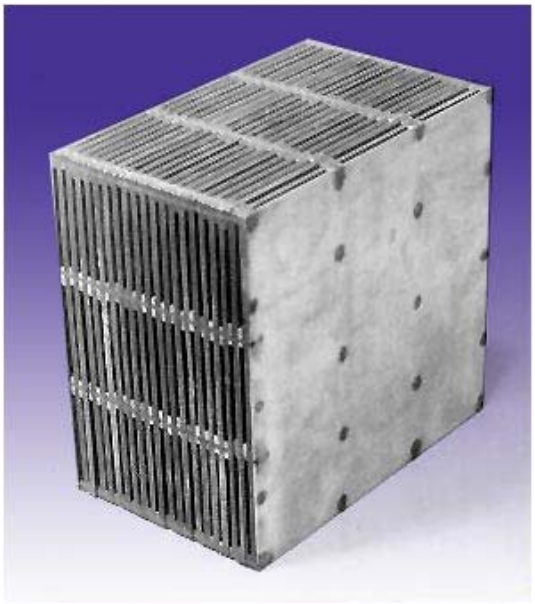

Fig. 1 High Temperature Heat Exchanger

National and International Project Experience

The department has performed the following projects on behalf of the National Academy of Sciences:

(i) Swirling flow heat transfer and hydrodynamics leading to the new internal cyclone blade cooling technique.
(ii) Dimple heat transfer and novel external oscillating blade film cooling technique.

As well as the following international projects:

(i) One- and two phase swirling flows (Royal Society, UK);
(ii) Novel blade cooling systems (NATO Scientific Committee);
(iii) Dimple technology (National Research Council, USA);
(iv) Novel cooling systems for gas turbine blades (CRDF, Ukraine);
(v) Novel heat transfer enhancement technique for high temperature heat exchangers (STCU, Ukraine).

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JSC Element

Organisation Description

JSC Element is one of Ukraine's leading certified developers and producers of electronic systems for measurement, parameters monitoring and control of aviation engines". Its turnover in 2009 was 3781000 UAH (i.e. about 328 500 euro) and it has 36 employees.

JSC Element develops measuring transducers, aviation control and monitoring systems, program and technical complexes of aviation engine testing, embedded real-time software, SCADA, monitoring and simulation systems, gas-turbine engine models, trend and correlation analysis.

Fig. 1 JSC Element's measurement systems

Research and Technology Development Activities

JSC Element carries out the following R&D activities:

- Identification of models and modelling of aviation engines, and other complex technical objects;
- Observing of not measured parameters or ones that aren't measured with necessary accuracy on base of aviation engine mathematical model;
- Methods and algorithms for aviation engine diagnostic;
- Processing of measured parameters and detecting of the GTE compressor surge;
- Pulsating combustion, measurement and processing of the pulsating pressure date;
- Optimization of wind-diesel power station;
- Developing of board system for operating in hard conditions and reliability assurance.

JSC Element provides the following services:

- development of software products – software for ACS TP (SCADA), monitoring, trend correlation analysis and databases;
- development of simulation and mathematical models; manufacture of small production series;
- execution of order on separate technological stage electronic assembling and mechanical operation;
- metrological testing and certification;
- research and development under above mentioned science-technical directions.

National and International Project Experience

JSC Element works in cooperation with Ukrainian, Russian, European and American companies and universities and takes part in ambitious projects such as:

- Antonov An-70, the next-generation four-engine medium-distance transport aircraft, and the first large aircraft to be equipped by propfan engines;
- Antonov An-148, the regional jet aircraft;
- Kamov Ka-226 "Sergei", the twin-engined utility helicopter;
- Tupolev Tu-334, Russian short to medium range airliner;
- HW&SW complexes for remote monitoring for Ukrainian Government Programmes;
- Kulite Semiconductor Products Inc (US), aircraft pressure transducers designer and producer;
- National Instruments (US), computer-based measurement and automation supplier.

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Kotris Ltd

Organisation Description

Kotris Ltd designs, produces, supplies and commissions process control systems for the aviation, oil and gas, chemical and municipal economy sectors. Kotris Ltd is an official representative in Ukraine for the following companies: Compressor Controls Corporation (USA), METRIX Instrument Co. (USA), AMOT (UK) and Motortecn GmbH (Germany).

Kotris' main research directions are technical diagnostics, industrial safety, resource and energy savings. Basic directions of activity are:

- vibration monitoring and diagnostics devices and systems;
- any complication systems for processes control of different branch of industry and municipal economy;
- industrial monitoring and supervisory control systems.

Research and Technology Development Activities

Kotris' main research activity is the development of real-time dynamic models (RTDM) of aviation gas turbine engines, hydromechanics and digital control systems. The basic data for the development of engine RTDM are setting geometry, rotors moments of inertia, mechanical efficiency factors, turboblade machines characteristics, separate engine units characteristics, loss and power takeoff values on the engine section and other. The basic data for the development of automatic control system hydromechanics RTDM are hydraulic circuits, geometrical and hydraulic parameters of units, metering characteristics and other.

The verification of the RTDM is carried out on steady-state regime calculation parameters compliance with the engine and hydromechanics developer appropriate static model. The basic functions of turbine engine RTDM are:

- transient calculation at the set changes of environment and control factors values;
- engine thermodynamics calculation of the altitude-speed curves;
- calculation of the operative modes lines.

Our basic technology is hardware and software for aviation gas turbine engine testing equipment together with automated modelling and diagnosing facilities ("KAI-25F"). The "KAI-25F" system is used for real-time synthesis and analysis of control laws and algorithms of automatic control systems during engine and laboratory tests. The "KAI-25F" system's functions include:

- automatic and hand remote engine control in process of engine tests and laboratory tests of hydromechanics;
- monitoring of the engine control system and hydromechanics measuring channels in process of motor tests;
- real-time simulation of gas turbine engine, hydromechanics and electronic digital control system algorithms and measuring channels.

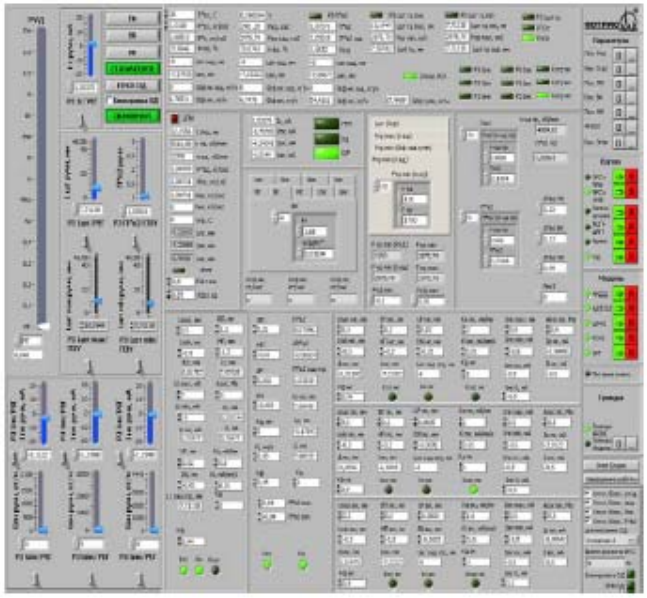

Fig. 1 "KAI-25F" control and supervision panel

The "KAI-25F" desk and supervision control console can be used for:

- process control and monitoring of parameters and signals of tested gas turbine engines in automatic and manual modes;
- bumpless transfer from automatic control mode to manual mode and back on an operator command in process of tests;
- auto and manual turning of control algorithm parameters of combustion chamber, afterburner and jet nozzle automatic stabilizing systems during real-time tests;
- remote monitoring of engine and control system parameters by ARINC429, RS232 and Ethernet interfaces.

National and International Project Experience

The "KAI-25F" complex has been successfully used during development and testing of the "AI-222K-25F" turbo-jet bypass engine with afterburner in the "Ivchenko-Progress" Zaporozhye Design Bureau.

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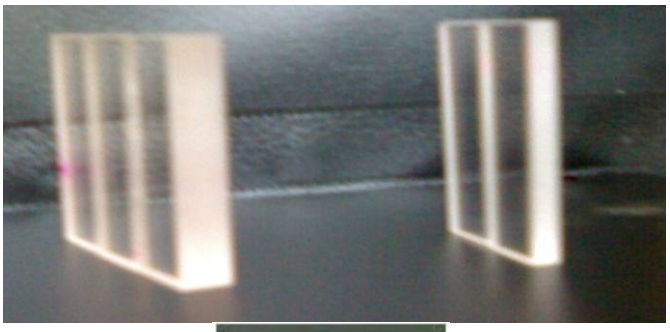
National Taras Shevchenko University of Kyiv
Faculty of Physics - Molecular Physics Department

Organisation Description

The molecular physics department takes part in works, which are carried out in frameworks of international collaborations. Unfortunately in Ukraine in the nearest future designing and construction of modern acceleration complexes, capable to help to investigate fundamental properties of a matter, is not provided. To this active participation of department in international collaboration allows taking part in preparation and carrying out of the advanced experiments.



Research and Technology Development Activities

- Development of the composition of liquid agents for the Self-healing Spacecraft systems,
- Study of the deformation properties and dispersion mechanisms of the paraffin-based ecological fuel,
- Development of the adhesives for manufacturing solar batteries and constractive elements of space apparatus.

The main technologies are described in articles:

- Bulavin L.A., Aktan O.Yu., Zabashta Yu.F., Orlovskaya S.G. The Deformation Properties and the Dispersion of Paraffin-Based Hybrid Rocket Fuel in the Process of the Combastion/ Modern Science (Collection of Research Papers) №2, 2009, pp. 3-5.
- Bulavin L.A., Aktan O.Yu., Zabashta Yu.F., Journal of Molecular Liquids-2005.-Volume 120.-C.139-141
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- Bulavin L. A., Aktan O. Yu. , Zabashta Yu. F. // Polymer Science. Ser.B., Vol.47, Nos 3-4. 2005.pp.109-113.
- Bulavin L.A., Aktan O.Yu., Lazarenko M.M.// Ukrainian Journal of Physics.-2005.-№9. – pp.952-957.
- Bulavin L.A., Aktan O.Yu., Nikolaenko T.Yu., Sheiko N.L. and Myagchenko Yu.A., Instruments and Experimental Techniques. № 3, p. 164-165, 2007.
- Todosiychuk T.T. Polymer Science, Series D, Vol,1 number 1, pp.23-27 (2008)
- Yarovaya N.V, Kosyanchuk L.F. Molecular Crystals and Liquid Crystals, 2008, Vol.483, number 2, p.191-204.
- Kalinchuk, Struchaev A.I., Orlovskaya S.G.Physics of combustion and explosion, number 1(1990), p,92-96.

And in patents:

- Bulavin L.A., Aktan O.Yu, Zabashta Yu.F. and Nikolayenko T.Yu., Ukraine Patent No 78094 (2007).
- Todosiychuk T.T., Krivchenko G.M., Yashenko L.M. Ukraine Patent No 84531 (2008).

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Lviv Polytechnic National University
Information Processing Systems Design Bureau

Organisation Description

Information processing systems design bureau of "Polytechnica" project and design association is part of Lviv Polytechnic National University.

Our organization is aiming on development and creation of modern radio-electronic equipment and specialized software for information and signal processing in real-time.

Research and Technology Development Activities

Development and creation of design, program and exploitation documentation.

Service personnel training.

Ready-made system implementation.

Development, design and creation of modern radio-electronic equipment using:

- Digital signal processors (DSPs);
- Field programmable gate arrays (FPGAs);
- High-speed analog-to-digital conversion devices (ADCs).

Software development and creation:

- Application programs;
- Device drivers;
- Specialized software;
- DSP firmware;
- FPGA configuration.

The main products/services delivered by Lviv Polytechnic are:

- Software and hardware processing of aircraft flight information.
- Flight information processing hardware development.
- Flight information processing software development.

National and International Project Experience

Lviv State Aircraft Repair Plant, Mobile complex of aircraft on-line control "Berkut": "Tester-U3-L" technical condition control device.

Fig. 1 Mobile complex of aircraft on-line control "Berkut"

Fig. 2 "Tester-U3-L" technical condition control device

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National Aerospace University "Kharkiv Aviation Institute"

Department of Aerodynamics and Acoustics

Organisation Description

The Department of Aerodynamics and Acoustics was founded at the National Aerospace University "Kharkiv Aviation Institute" (KhAI) in 1934. Since then the Department has been training specialists in airplane aerodynamics and flight dynamics, does research for national airforce, civil/transport aviation and national economy. The department has the following laboratories and facilities:

- Acoustics Laboratory equipped with aeroacoustic chamber (size – 3x3x4.5 m, range of frequencies – 125 ÷ 8000 Hz)
- Subsonic Aerodynamics Laboratory
  - Subsonic wind tunnel T-3 (velocity up 45 m/s; diameter of flow core 1.2 m; length of working section 2.3 m; initial degree of turbulence 0.06%)
  - Subsonic wind tunnel T-4 (velocity up 60 m/s; diameter of flow core 1.2 m; length of working section 2.3 m; initial degree of turbulence 0.08%)
- Supersonic Aerodynamic Laboratory equipped with Supersonic wind tunnel T-6 (Mach number – 0.5÷4; cross section – 0.6x0.6 m; length of working section 1.3 m)
- Study Hydraulic Laboratory
- Study Wind Tunnels T-5 (velocity up 35 m/s; diameter of flow core 0.6 m; length of working section 1.5 m)

Research and Technology Development Activities

- Computational fluid dynamics;
- Wind tunnel tests and experimental determination of aerodynamic characteristic of any type of vehicle, such as airplanes, helicopters, missiles, cars, submarines and buildings;
- Transport aerodynamic performances optimization (aerodynamic drag decreasing) and aircraft efficiency improvement;
- Theoretical investigation of aircraft stability;
- Noise and acoustic wave investigations;
- Theoretical and experimental investigation of aerodynamic performance vertical-axes wind turbine;
- Generation of plane aspect and choice of vehicle rational parameters;
- Design of vehicle aerodynamic configuration;
- Development of analytical algorithm and software for aerodynamic performances calculation (according to customer conditions);
- Wind tunnel models design and manufacture;
- Subsonic, supersonic wind tunnel tests;
- Aerodynamics research of surface transport;
- Aeroacoustics research of transport;
- Numerical simulation (CFD) and investigation of aerodynamic processes.

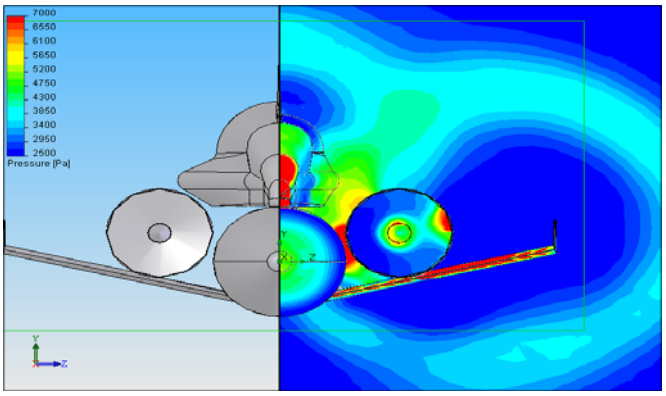

Fig. 1 Ukrainian Space Shuttle (SURA) aerodynamic performance investigation

Fig. 2 Supersonic Wind Tunnel T-6

National and International Project Experience

R&D projects have been undertaken with the Ukrainian organisations SDO Yuzhnoye, National Space Agency of Ukraine, Institute of Technical Mechanics, SDO Luch and ANTONOV ASTC. However, details of the projects are protected by confidentiality agreements.

R&D projects have been undertaken with numerous international organisations. However, details of the projects are protected by confidentiality agreements.

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National Aerospace University "Kharkiv Aviation Institute"

Department of Aviation Material Science

Organisation Description

The Aviation Material Science Department conducts research and provides specialist training in aviation material science and physical-mathematical models for design and manufacturing of structures made of fibre reinforced materials with polymeric matrix (polymer composite).

The department's scientific results have been published in more than 100 specialized journals, including 23 articles, 6 textbooks (with Ministry of Education and Science stamp) and about 20 citations in ASTC Antonov scientific reports over 2004-2009 period. Our employees regularly take part in Ukrainian and international conferences and workshops.

The department has a specialized Composite Material Laboratory fully equipped with all the necessary facilities to develop manufacture and test composite/CFRP components and structures (oven, vacuum system, autoclave (up to 5 atmospheres), tensile-testing machine, etc.)

Research and Technology Development Activities

Our highly trained staff are experienced in:

1. Development of analytical models for design and calculation of composite aeronautic structures
2. Development of innovate composite-to-composite and composite-to-metal joints with increased characteristics in comparison with traditional ones.
3. FEM simulation and checking calculation of composite materials structures.
4. Verification of finite element and analytical models by holographic interferometry.
5. Composite structures curing process optimization and control.
6. Design and production of efficient heating tool.
7. Experimental determination of strength, electric and thermal (thermal expansion coefficient and shrinkage) characteristics of polymeric and reinforced materials.

We are able to propose the following technologies/services for international cooperation and joint projects:

1. Set of mathematical models and analytical design algorithm for thin anisotropic structures stress-strain state determination that take into account initial technological stresses.
2. Method for cure process time-temperature conditions determination for predefined cure degree obtaining with minimal time and energy consumptions.
3. Method for manufacturing tool and additional layers rational parameters determination for reduction of thermal field non-uniformity in cured part.
4. Design and technological solution of innovative metal-to composite joints and methodology for joint analytical and experimental analysis.

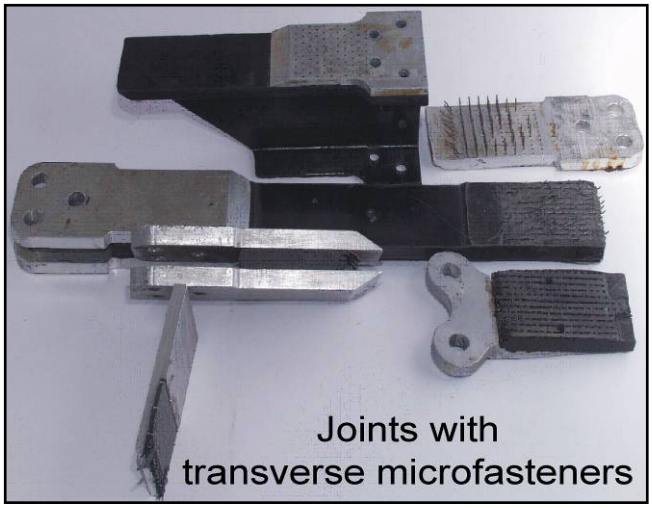

Fig. 1 Heterogeneous Composite-to-Composite and Composite-to-Metal heavy-loaded joints (composite structure weight savings of 34%)

Fig. 2 Flexible heating blanket (conductive element - carbon fibre) and heat-control unit for composite repair patch curing

National and International Project Experience

European Commission funded FP6 ALCAS ("Advanced low cost aircraft structure") and FP6 SENARIO ("Advanced Sensors and Novel Concepts for Intelligent and Reliable Processing in Bonded Repairs"). EOARD funded "Joints of article made of polymeric composite materials". Also, numerous composite research projects funded by State Funding for Fundamental Investigations of the Ministry of Education and Science.

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National Aerospace University "Kharkiv Aviation Institute"

Department of Information Technology

Organisation Description

Kharkiv Aviation Institute was founded in 1930. The Institute conducts research and provides specialist training in aircraft construction, aviation motor engineering, aircraft control systems engineering and radio engineering. Following Ukraine's independence, the institute was renamed National Aerospace University "Kharkiv Aviation Institute".

The Department of Information Technology has three Full Doctors of Science, four Candidates of Science, and three postgraduate students. The department is well equipped with computer hardware and software and has over 25 years of experience in numerical modelling and simulation.

The department's results have been published in about 150 science journals and proceedings. For example, 7th European Conference on Turbomachinery (2007, Athens, Greece) and 21st International Colloquium on the Dynamics of Explosions and Reactive Systems (2007, Poitiers, France).

Research and Technology Development Activities

- numerical modelling of gas flows in complex form channels (including chemical reactions);
- design and test maintenance of aerodynamics objects: axial-flow and centrifugal blowers, axial-flow and centrifugal compressors, ejectors, heat-exchange devices, catalytic converters;
- numerical modelling of gas mixing at atmosphere and industrial plants (determination of pollutant gases hot spots, combustion and explosion of inflammable gases, risks assessment of man-caused emergency conditions);
- design and test maintenance of distillers;
- computational fluid dynamics, finite-difference and finite volume methods;
- computational multi-objective optimization methods;
- 3D CFD codes, CAE-systems, CAD-systems, computational decision support systems on the basis of inverse problem quasi-solutions searching for turbomachines and industrial aerodynamics design;
- technologies of flow separation control;
- computational methods of gas turbine engine diagnostic analysis;
- computational decision support systems for risk assessment of man-made emergency conditions;
- technologies for environmental protection.

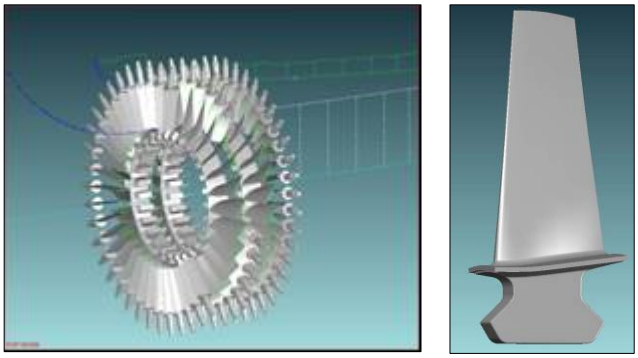

Fig. 1 Multi-stage axial flow compressors AN250 & AN300 developed for Nuovo Pignone S.p.A

National and International Project Experience

1) STCU projects (2002-2004): "Designing Energy-Technological Complex for Producing Ecologically Pure Energy Carriers and Subproducts" (UZB-23j); "Development of the nonmonophase jet device for milk heat, thermal treatment and other alimentary solution regeneration" (UZB-33j); and "The development of the experimental installation for fast freezing of fruits and berries" (UZB-35j).

2) Industry projects: Nuovo Pignone S.p.A. (GE Power Systems, Oil & Gas, 2002-2003); Center for Advanced Systems Development of the Doosan Heavy Industries & Construction Co., (Daejeon, South Korea, 2007-2008); China Aviation Industry Corporation II (China Aviation Powerplant Research Institute, Zhuzhou, 2008).

3) Russian projects: State Research Center of Russian Federation Central Institute of Aviation Motors (Moscow, Russia), NPO Saturn (Moscow, Russia), N.D. Kuznetsov Samars Scientific and Technical Complex Company (Samara, Russia), State Unitary Enterprise 'Klimov Plant' (St.-Petersburg, Russia) and OJSC Aviadvigatel (Perm, Russia).

4) Ukrainian projects: State Enterprise "Progress" Zaporozhye Machine-Building Design Bureau and Motor Sich JSC.

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National Aerospace University "Kharkiv Aviation Institute"
Department of Aviation Engine Design

Organisation Description

Kharkiv Aviation Institute was founded in 1930. The Institute conducts research and provides specialist training in aircraft construction, aircraft engine development, aircraft control systems engineering and radio engineering. In 2000 the Institute was renamed National Aerospace University "Kharkiv Aviation Institute".

The Department of Aviation Engine Design has two Full Doctors of Science, ten Candidates of Science, and three postgraduate students. The department is well equipped with computer hardware and software and has over 30 years of experience in turbine engine monitoring, diagnostics, numerical modelling and simulation.

The department's scientific results have been published in about 100 science journals and proceedings in Ukraine and abroad, including Proceedings of GT2007 ASME Turbo Expo 2007 & Proceedings of GT2008 ASME Turbo Expo 2008.

Research and Technology Development Activities

- gas turbine engine parametric diagnostics;
- development of fast calculated multi-mode dynamic models of turbine engine;
- turbine engine real-time simulation procedures for semi-natural test-cells and on-design face of electronic control system;
- sensor faults detection procedures using information redundancy and engine subsystem mathematical modelling;
- turbine engine in-flight data (normal and abnormal condition) simulating for debugging and algorithm's checking purposes;
- development of combustor, including innovative design for further NOX reduction;
- development of the technical basis for defining an engine emissions index that accounts for the whole flight cycle;
- development of analytical and experimental techniques for modelling the kinetics of combustion and related computational fluid dynamics;
- development of technologies for advanced combustor and injector systems with regard to NOx, soot and unburned hydrocarbon;
- lifetime depletion of critical gas turbine engine parts monitoring methods based on dynamics temperature and stress states identification;
- development of the fast calculating monitoring models of temperature and stress state critical turbine engine parts on steady-state and transient modes based on upper level computer models;
- integration of monitoring models of temperature and stress states into lifetime depletion account systems.

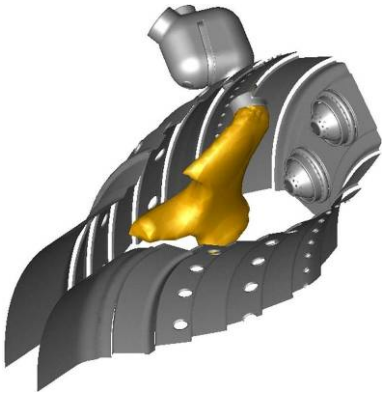

Fig. 1. CFD analysis of pilot burner fire and flame tube air flow interaction

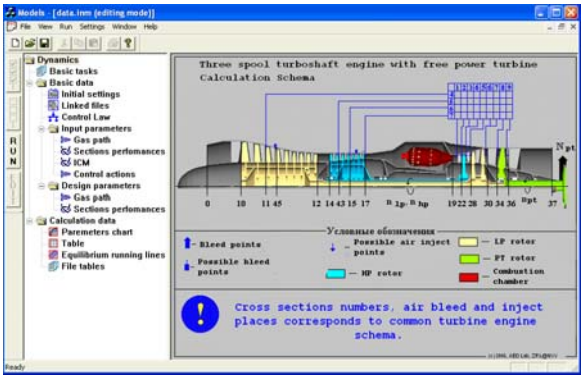

Fig. 2. The view of interface of turboshaft engine dynamic model

National and International Project Experience

1) Industry projects: Center for Advanced Systems Development of the Doosan Heavy Industries & Construction Co., (Daejeon, South Korea, 2007-2008); China Aviation Industry Corporation II (China Aviation Powerplant Research Institute, Zhuzhou, 2008).

2) Russian projects: State Research Center of Russian Federation Central Institute of Aviation Motors (Moscow, Russia), NPO Saturn (Moscow, Russia) and OJSC Aviadvigatel (Perm, Russia).

3) Ukrainian projects: State Enterprise "Progress" Zaporozhye Machine-Building Design Bureau and Motor Sich JSC, OJSC "Turboatom", SPE "Zaria-Mashproekt".

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National Aerospace University "Kharkiv Aviation Institute"

Department of Aircraft Manufacture

Organisation Description

The department of aircraft manufacturing is one of the leading scientific units of National Aerospace University "KhAI". It was founded in 1930 simultaneously with University foundation. Currently, the Department is the leading centre in aerostructures manufacturing methods development.

We provide the research activity in the areas of modern enhanced methods of aircraft assembling, metal forming (including high-speed impulse technologies), blanking, machining, welding, plasma technologies et al. The Department has five well-equipped scientific laboratories:

- Laboratory of electrohydrodynamic stamping.
- Laboratory of welding and facing.
- Laboratory of metal forming and sheet stamping.
- Laboratory of impulse riveting.
- Laboratory of impulse technologies et al.

Our national and international co-operative experience with Boeing, Ford and other companies confirms our excellent scientific potential.

Research and Technology Development Activities

Our main research activities include:

1. Development of modern enhanced "intelligent" aircraft production.
2. Enhanced methods of manufacturing for improving cost efficiency.
3. Thermal treatment for tool tips, removal of imperfections.
4. Modern technologies for coating (sputtering + laser modification).
5. Development of methods for increased application of adaptable rigging (machining in modern machining centers).
6. Modern control of manufacturing processes and quality in sheet-stamping production.
7. Enhances methods of production of metalized lightweight composite materials with integrated electrical conduction.
8. Upgrading of press equipment for forming and sheet stamping in aircraft production.
9. Sheet stamping by means of high-speed cumulative influence of transmission medium.
10. Development of technology and tools for impulse (high-speed) riveting of aerostructures.
11. Technology and equipment for high-speed (impulse) metal forming.
12. Development of enhanced high-lifetime plasma generators

Fig 1 Single-impact impulse riveting hammers developed at KhAI

Fig 2 Impulse self-piercing riveting

The department of aircraft manufacturing is well-known for its success in high-speed/impulse metal-forming techniques. The developed unique impulse equipment allows one to obtain structures with predictable properties that cannot be obtained by traditional manufacturing techniques. Our advanced researches in welding and plasma technologies allow us to get innovative scientific results. Our experienced engineers provide the FEM simulation in modern computer programs (e.g. ANSYS, ABAQUS, etc.)

National and International Project Experience

1/ Boeing - Composite Laminates Titanium Riveting Technology Development with Process Parameters Optimization (2007-2008)

2/ Ford Motor Company – Mass serial manufacturing of automotive panels by means of electrohydrodynamic stamping (2007-2009)

3/ Bi-lateral contracts with Evektor (Czech Republic), Flight Design (Germany).

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National Aerospace University "Kharkiv Aviation Institute"

Aircraft Control Systems School

Organisation Description

The Aircraft Control Systems School was founded in 1977. Now it has 5 departments with 1023 students, 83 teachers and researchers, 65 members of support personnel. The School is well known for its graduates which were working and are working at the enterprises of aerospace industry of former Soviet Union, Ukraine and other countries. They design and produce world famous aircrafts "Antonov", "Sukhoi" and others, rockets, satellites and other complicated technical systems. Some of them scored big professional success and became chief designers and general managers.

The teachers, scientists and students of the School are performing different research projects successfully for large-scale aerospace and other enterprises and organizations of Ukraine, Great Britain, Austria, Germany, Mexico and China. Since 1998, 10 dissertations of Doctor of Technical Sciences and 48 dissertations of Ph.D. (Candidate of Technical Sciences) were defended by teachers and researchers of the School. Since 2002 more than 200 patents for invention were received by teachers, researchers and students of the School.

Fig 1 The bench for fault-tolerant sensors units research

Fig 2 The bench for fault-tolerant engines-flywheels research

Research and Technology Development Activities

Our main research activities are focussed on:

- development of aircraft control systems with the capability of active fault-tolerance;
- development of methods, models, algorithms of aircraft control system state deep diagnosing;
- development of methods and models for aircraft control systems diagnosis;
- development of methods, models, algorithms of aircraft control systems functions recovery after faults and airframe damages;
- modelling of aircraft control systems with the capability of active fault-tolerance;
- experimental research of aircraft control systems by means of designed benches and computer programs;
- development of new classes of unmanned aircrafts;
- development of the computer system for revelation persons who are connected with terrorist and criminal groups.

National and International Project Experience

1/ "Ostrov" enterprise: Development of automation system for monitoring of climatic parameters of modern hatchery.

2/ Volchansk Aggregate Plant: Development of control system for environmental camera "BlueStar".

3/ Grant for 25 avionics specialists from corporation AVIC (China) training on modern principles of aircraft control systems development (2005)

4/ Scientific grant of University of Applied Sciences, Zittau/Gerlitz, Germany was successfully performed by professor A. Kulik (2008)

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National Aerospace University "Kharkiv Aviation Institute"

Autonomous Power Source Laboratory

Organisation Description

The laboratory's main area of R&D is power-supply systems development for modern space-rocket complexes and spacecrafts vehicles. Over the past 15 years, the laboratory team has worked with leading Ukrainian R&D organizations: SDO Yuzhnoye, Institute of Semiconductor Physics of the National Academy of Sciences of Ukraine, Scientific Research Technological Institute for Instrumentation, Experimental design bureau of production association "Kharkov plant of electrical equipment" of the National Space Agency of Ukraine. It has participated in numerous contracts and state budgetary projects such as "Base", "Start", "Sich", "Sich-1M", "CORONAS-I", "Lubid", "Poperedzhennja", "Microsatellite" and "EgyptSat".

Research and Technology Development Activities

The laboratory team performs work in following fields:

1. Development of automated test benches, tools, simulators and physical models for aircraft and spacecraft testing:
   - complex automated modeling test benches;
   - equipment for imitating thermal modes;
   - specialized gauges for researches, tests, certification of electrochemical batteries;
   - information-operating systems for automating tests;
   - bench equipment for conducting prolonged life tests of electrochemical batteries by imitating working conditions of power supply systems in normal modes of operation;
   - bench equipment for diagnosing and recovering alkaline electrochemical accumulators.
2. Development of models, algorithms and software for experimental working-off and testing units and power-supply systems of aircrafts and spacecrafts.
   - specialized techniques and algorithms for processing experimental data;
   - procedure of calculating power losses of electrochemical accumulators;
   - method for estimating internal resistance of electrochemical accumulators.
3. Experimental researches of physical processes and electrochemical accumulators and power-supply systems batteries testing.
   - diagnostics and all kinds of testing power-supply systems;
   - experimental researches of physical processes in power-supply systems;
   - power-supply systems lifetime prolongation.
4. Research of new structures of power supply sources on the basis of synthesizing mathematical models of units and systems of power-supply systems.
5. Power-supply systems calculation and design

The laboratory team offers the following services:

1) Models and methods for electrochemical accumulators diagnosing, restoring, forecasting characteristics and lifetime prolongation;
2) Automated test benches and equipment development for experimental research of electrochemical accumulators and batteries.

The team develops the following unique equipment:

1) Electrochemical accumulators express diagnosis

We offer a device, which allows providing full diagnostics of accumulators avoiding charge-discharge cycles and interfering in operational logic. It allows in short time to determine main parameters of accumulators: charge/discharge characteristics, voltage-current characteristic, actual capacitance, state-of-charge and internal resistance.

2) Electrochemical accumulators restoring

We offer a device allowing restoring of electrochemical accumulators of different electrochemical systems to their operating condition. With its help one can restore degraded electrochemical accumulators for repeat using by increasing their capacity by 30…40%. Offered device also allows providing control and training cycles of accumulators, thus, increasing life of accumulators and improving their operation conditions.

3) Electrochemical accumulators life tests

Available facilities, methodologies and operational experience allow various life tests conducting: real-time life tests in the automated mode imitating on-board operation of accumulator as a part of power-supply system, and the accelerated life tests of accumulators.

National and International Project Experience

Conducting fundamental scientific researches in the field of power-supply systems of aircrafts (Ministry of Education and Science of Ukraine)

Development of accumulator restoring techniques and carrying out restoration procedures (Ministry of Defence of Ukraine).

Equipment development and performing of diagnosis, restoration and accelerated tests of electrochemical accumulators and batteries of different types (State Design Office "Yuzhnoye").

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National Aviation University
Centre of Environmental Problems of Airports

Organisation Description

The National Aviation University (NAU) was established in 1933 for the education and training of specialists in civil aviation. There are more than 25,000 students studying in the University at the moment, including all necessary specialties for airports, airlines, design offices and other aviation organisations. Research is carried out on: improvements on aircraft operational processes, on air traffic control, on flight and maintenance provision and on safety, including the problems of environment protection.

The Centre of Environmental Problems of Airports, which includes the Acoustic Laboratory and several specialised groups, was established in NAU for solving particular tasks of Environment Protection in and around airports. The main purpose of the Centre is to define the protection zones around airports and aerodromes of civil aviation for the dominant ecological factors: noise, air pollution, electromagnetic fields and third party risk. The work is done in accordance with existing national rules (Civil Aviation Authority, Environment Protection Ministry and Ministry of Health Protection of Ukraine), which were developed with leading participation of NAU in accordance with ICAO recommendations.

Research and Technology Development Activities

The centre's research is concerned with operational procedures and airport measures for noise and air pollution reduction:

- Identification Task of Aircraft Noise Models;
- Sound Propagation Models (Air Absorption, Directivity Patterns, Lateral Attenuation, Acoustic Screen Effects);
- Models of Exhausted Jets Based on Semi-Empirical Theory of Turbulent Jets;
- Models Of Aircraft Engine Emission;
- Aircraft Crash Location Model and Aircraft Crash Consequences Model;
- Optimal aircraft flight profiles (take-off and approach flight stages) for minimum noise and air pollution around airports;
- Noise and vibration performances measurements in acoustic chambers, recommendations for their minimization.

The main technologies and services we offer include:

1. Semi-empirical methods for assessment of Aircraft Noise Levels and Noise Exposure around Airports;
2. Methods for assessment of Air Pollution Concentrations around Airports;
3. Methods for assessment of Third Party Risk around Airports;
4. Numerical Methods for Optimization of Aircraft Trajectories and Flight Scenario for Minimum Noise and Air Pollution Impact around Airports;
5. Development of software tools for acoustic signal analysis and synthesis in aircraft cabins and its implementation in production.

Fig. 1 Noise testing

National and International Project Experience

NATO project: "Prediction of noise from aircraft" with University of Hull, UK.

European Commission projects: FP5 SILENCE(R) ("Improving prediction models for noise footprint calculations in a part of sound propagation and installation effects in operating conditions", G4RD-CT-2001-OQ500); FP5 X2-NOISE (G4RD-CT-2002-05102); and FP6 X3-NOISE ("Aircraft External Noise Research Network and Co-ordination", ACA5-CT-2006-030840).

Ukrainian Ministry of Transport projects: "To develop and to implement in one of the airports of Ukraine the aircraft noise monitoring system, technique of calculation, forecasting and compensation of aircraft noise impact"; "To conduct researches with the purpose of implementation of acoustic screens at the airports of Ukraine"; and "To develop a technique of calculation of concentration of air contamination produced by aircraft engine emissions".

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National Aviation University
Department of Radioelectronics

Organisation Description

The Radioelectronics Department of the National Aviation University conducts research and provides specialist teaching (BSc, MSc, and PhD) in the field of electronics including electronic systems and avionics. The scientific and academic staff includes: 8 Professors, DSc, PhD; 10 Associate Professors, PhD; 10 Assistant Professors and Engineers, MS. Permanently, the department has 10 PhD students.

The department's main research directions include: 1) Remote detection and estimation of dangerous weather phenomena for aviation safety; 2) Doppler-polarimetric radar; 3) Surveillance systems including multilateration, secondary radar, ADS-B, and TCAS; 4) Noise immune coding and cryptographic protection of information; and 5) Compression of signals and images.

During the past two years, 4 monographs (one in CRC Press) and over 100 scientific papers have been published, among them 20 papers in refereed international journals (IEEE Transactions and others). 12 patents were filed and 4 PhD dissertations defended.

Research and Technology Development Activities

The main technologies and services we offer include:

- Application of mathematic tools of probability theory, statistical and imitation simulation, theory of signal processing;
- Mathematical modelling of Doppler-polarimetric scattering on arbitrary hydrometeors;
- Computer simulation of Doppler-polarimetric signals and images;
- Radar polarimetry. Radar pattern recognition. Radar signal processing (including statistical synthesis of algorithms). Mathematical modelling and computer simulation of processes and systems;
- Modelling of secondary radar environment and multilateration systems;
- Microwave remote sensing of clouds and precipitation with microwave radar and noisy acoustic radar (sodar);
- Multi-parametric signal processing. Combining of passive and active methods;
- Measuring of physical quantities. Adaptive methods of measuring under the condition of severe external action;
- Development of applied software tools for remote sensing data and signal analysis;
- Experimental remote sensing with Doppler-polarimetric radar and prototype of noisy atmospheric sodar;
- Fuzzy logic and neural network algorithms for signal processing and pattern recognition;
- Modelling in MATLAB™ ModelSim™ and other media;
- Signal processing in real time and also processing of raw data of the remote sensing previously written digital carrier.

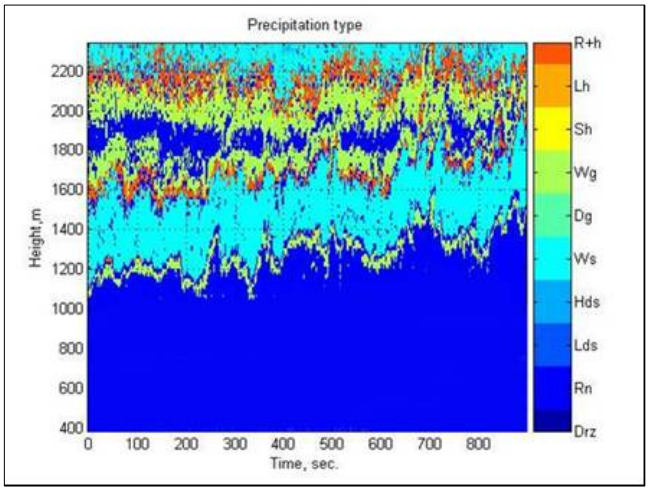

Fig. 1 Radar hydrometeor type recognition

National and International Project Experience

The department has conducted numerous research projects with IRCTR-TU Delft, Holland, and the Technical University of Hamburg-Harburg, Germany. Example projects with IRCTR-TU Delft include:

- "Critical assessment of the specifications of the transportable radar TARA with respect to its feasibility for atmospheric remote sensing" Contract No IRCTR-S-020-97;
- "Critical assessment of the Doppler-polarimetric model that relates polarization and Doppler characteristics and turbulence".
- "IAWIS: Airport weather Radar System for wind shear detection and prediction (AWERS / WISDP)", IRCTR-S-006-03.

The department has conducted numerous national research projects for the Ministry of Transport, Ministry of Education and Science as well as the State Research Institute Buran. These include:

- "To develop algorithms for the detection of hail centres for airfield and airborne meteorological radars of a new generation". Contract No 552-ГБ95, State Registration # 0195u008291.
- "The concept of the system for localization of zones of dangerous weather phenomena and proposals to the project of the requirement specification on the development work 'System of thunderstorm activity detection'". Contract No СБ-1К-90.

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National Aviation University

Department of Automatisation and Energy Management

Organisation Description

The Automatisation and Energy Management Department has an up-to-date laboratory that includes wind tunnel and equipment to research how sudden damage during flights can affect the aerodynamic qualities of planes. In order to carry out the research, models of plane wings are created that contain the optimum amount of sensors to register moment, degree and location of typical impacts that can be later used in control law.

The department has 1 Doctor of Science, 4 Candidates of Science and 5 PhD students involved in research. The department has published two monographs and over 55 articles on its research.

Research and Technology Development Activities

Our research focuses on system methods for aircraft conservation, operation and contingency during exceptional circumstances. This includes:

- Diagnostic techniques for aircraft external outline as well as method of control reorganization during sudden damage to planes;
- Development of system method of conservation of controllability for aircraft in exceptional circumstances and contingency during the flight;
- Method preparation of rule base forming and development of decision-making techniques and support for crew in existing flight situations;
- Development of operation algorithms and structure for on-board intelligence system to prevent existing contingency during the flight from becoming catastrophic.

The main technologies and services we offer include:

- Optimal placement of sensors to register moment, degree and location of typical damages impacts during flights;
- Creation of rule base on the basis of past positive crew actions in similar situations in order to prevent contingency during the flight;
- Implementation of scale-down experiments to prove method efficiency for aircraft external outline during flight.

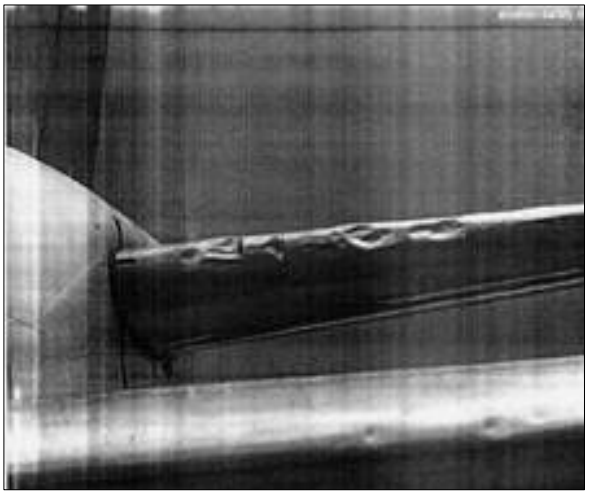

Fig. 1 Typical plane damage

National and International Project Experience

We work extensively with Ukrainian industrial enterprises including JSC Ukrtransgas, Aviant, Artem and Antonov. Also, we implement projects on behalf of the Ministry of Science and Education of Ukraine such as “Theory, methods and principles of diagnosis of aircraft external outlines aerodynamic condition during flight”.

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National Aviation University

Aircraft Strength and Fatigue Life Laboratory

Organisation Description

The Aircraft Strength and Fatigue Life Laboratory conducts fundamental and applied research concerning operational reliability and aircraft durability. The standard and original test equipment allows tests to be performed in a wide range of loading conditions.

Research and Technology Development Activities

i) Nanoindentation tester “Micron-Gamma”:

“Micron-gamma” is multi functional precision instrument which include a hardness and scratch tester. It has been designed to provide surface mechanical characterization data by indenting and scratching with nanometer-micron scales. This nanoindenter can be used to characterize organic, inorganic, soft or hard materials and coatings. Examples are thin and multilayer PVD, CVD, PECVD, photoresists, paints, lacquers, and many other types of films and coatings. Bulk material surface mechanical characterization can also be performed on hard or soft materials, including metals, semiconductors, glasses, ceramics, composites, and biomaterials.

The depth sensing indention technique is based on automatic registration of load applied to the indenter and depth of its penetration. Results are presented in the form of load-displacement diagrams. Processing of these diagrams allows us to determine the materials micro hardness and Young's modulus, investigate materials creep behaviour. The scratch testing technique is based on continuous registration of resistance to indenter movement along the surface with a specified load. This method gives ability characterize the film-substrate system and to quantify parameters such as friction and adhesive strength**.**

ii) Non-contact surface profiler “Micron-alpha”

“Micron-alpha” quickly and accurately measures the 3D topography of surfaces at the nanometer level. It is designed for the researcher who is interested in getting fast, repeatable date from an instrument that is not encumbered by unneeded levels of complication.

iii) Computer aided optical complex for aircraft fatigue damage estimation based on surface deformation relief parameters:

The method allows the estimation of fatigue damage. It can be applied to full scale fatigue testing of aircraft constructions in order to define where fatigue cracks are likely to begin forming. Also, the method allows the determination of an aircraft construction’s residual life under variable amplitude cyclic loading.

iv) Fatigue test equipment allowing tests to be performed according to ASTM standards:

- Standard Test Methods for Tension Testing of Metallic Materials (E 8);
- Standard Test Method for Measurement of Fatigue Crack Growth Rates (E 647);
- Standard Test Method for Measurement of Fracture Toughness (E 1820).

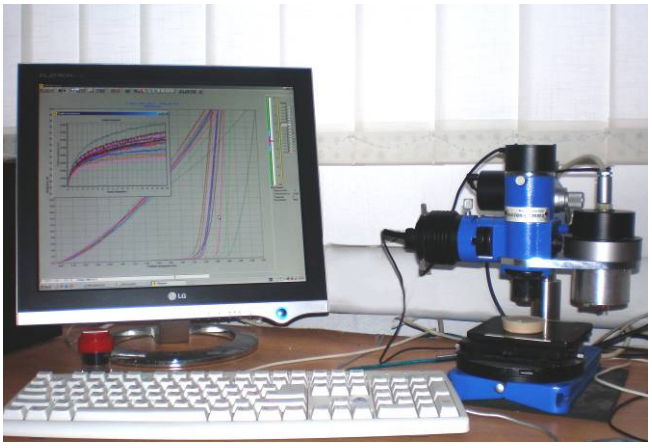

Fig. 1 Nanoindentation tester “Micron-gamma”

Fig. 2 Surface profiler “Micron-alpha”

v) Fatigue test equipment allowing tests to be carried out according to variable amplitude test programs:

- TWIST/MiniTWIST
- HELIX/FELIX
- FALSTAFF, etc.

National and International Project Experience

Investigations funded by the Ministry of Science and Education and research ordered by the national aviation industry.

During 2000 – 2002, the laboratory’s researchers took part in the INTAS-AIRBUS project “Surface relief fatigue indicator”, together with Airbus, University of Malaga, and Institute of Metal Physics.

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National Technical University of Ukraine "Kyiv Polytechnic Institute"
Faculty of Air-Space Systems

Organisation Description

The National Technical University of Ukraine 'Kyiv Polytechnic Institute' (NTUU KPI) is one of the oldest and largest technical universities in Europe. It was founded in 1898. NTUU KPI is famous for its academic excellence and leading innovative research. NTUU KPI is ranked first nationally and also has worldwide recognition. 40,500 students (including 1500 overseas students) study at 29 University Colleges. NTUU KPI's students receive the highest level of education provided by the Academic and Research staff. There are 58 Academicians and 10,000 Professors and Researchers among its active faculty.

NTUU KPI is a leading university in the following areas of science, research and development:

- information technologies, system analysis and management;
- airspace systems;
- electronics, radio engineering and communications;
- electrical engineering and energy saving;
- material science and mechanical engineering;
- power engineering and power generating technologies;
- instrument manufacture and measurement technologies;
- Ecology

Research and Technology Development Activities

NTUU KPI's aeronautics research activities include:

- Gyroscopic and pressure sensors, accelerometers
- Strap down inertial navigation systems
- Integrated systems of orientation and navigation
- Intellectual control systems
- Image recognition systems
- Electronic chart display and information systems
- Construction of flying vehicles
- Aerodynamics of flying vehicles
- Aeroelasticity of flying vehicles
- Flight dynamics of flying vehicles

National and International Project Experience

1. Ministry of Science and Education of Ukraine: Remote control and near Earth space monitoring micro satellites designing.

2. Ministry of Science and Education of Ukraine: Flying vehicles control systems designing.

3. Ministry of Science and Education of Ukraine: Artificial intelligence flying vehicles navigation and control systems design.

4. EC Tempus: Curricula Reform in Space Technology in Kazakhstan, Russia, Ukraine;

Fig. 1


Fig. 2

5. FP7 ERA-NET: EU-BSEC-Network on policy in the sphere of energy and climate changes PRJMITHEAS-2.

6. INTAS Project: Advance grooved heat pipe for space satellite thermal control system.

7. UNESCO Project: International Preadmission Training Centre of Excellence.

8. EC Tempus: Bridging the gap between University and business.

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National Technical University of Ukraine "Kyiv Polytechnic Institute"
Department of Instruments and Systems of Orientation and Navigation

Organisation Description

The National Technical University of Ukraine 'Kyiv Polytechnic Institute' (NTUU KPI) is one of the oldest and largest technical universities in Europe. It was founded in 1898. NTUU KPI is famous for its academic excellence and leading innovative research. NTUU KPI is ranked first nationally and also has worldwide recognition. 40,500 students (including 1500 overseas students) study at 29 University Colleges. NTUU KPI's students receive the highest level of education provided by the Academic and Research staff. There are 58 Academicians and 10,000 Professors and Researchers among its active faculty.

The Department of Instruments and Systems of Orientation and Navigation (ISON) was founded in 1960 and is a part of the Instrument Design and Engineering Faculty. The Department trains specialists for bachelor and master degrees for enterprises and scientific institutions involved in aircraft construction, aerospace industry, and instrument-making industry. ISON carries out research in the following fields: means of orientation and navigation; aircraft control systems; signal processing in orientation and navigation systems; operational diagnosis of aircraft engines rotary elements; non-destructive testing and damages evaluation of aerospace objects structural elements.

Research and Technology Development Activities

The Department of Instruments and Systems of Orientation and Navigation has considerable experience in carrying out investigation and research in the following scientific directions:

- development of signal processing methods and control algorithms for the Inertial navigation systems (including strapdown systems);
- the static and dynamic characteristics of the vibratory gyroscopes investigation and improvement;
- spacecraft orientation and stabilization systems development and improvement;
- development of the methodology of vibratory and vibroacoustical diagnosis of aircraft engines rotary details;
- development of intelligence system for flight information processing and decision making of aircraft engines rotary details condition.

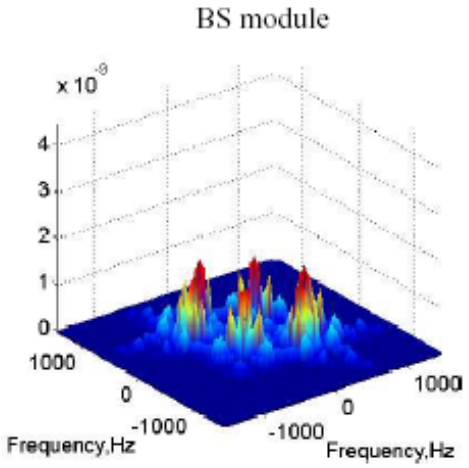

Fig. 1 Vibroacoustic diagnosis of crack-like damage in aircraft engine blades

National and International Project Experience

1/ The Ukrainian Centre of Aeronautical Engineering Operation (Ministry of Transport), "Investigation of the helicopter main rotor fan condition for the scientific foundation of the operation with the increased no-failure lifetime".

2/ JSC STE "Electronprylad", "Methodology of vibratory and vibroacoustical diagnosis of aircraft engines blades conditions at the steady-state and non-steady-state modes of operating".

3/ NTUU "KPI", "Modernization of the method of compass adjustment (magnetic deviation) for the aircraft course systems".

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Odessa National Polytechnic University

Institute of Radioelectronics and Telecommunications - Diagnostics Laboratory

Organisation Description

The scientific and research laboratory “Diagnostics” has been carrying out - over the past 20 years - development and implementation of modern methods of control of different types of power equipment (turbines, aero engines and rocket-powered engines and the plants on their basis). PhDs and Doctors of technical science work at the laboratory.

Objective of the work – creation of a generalized structural model which describes the signal monitoring systems and the development of a methodology for diagnostics of the technical condition of power plants.

Method of investigation – formation and analysis of mathematical models that describe the characteristics of power equipment, and experimental studies of the parameters of the power equipment by analyzing records of tests of power equipment, as well as participation in pilot studies on test stands.

In case of need, devices requiring atypical data processing methods can be developed and used for the design of control, diagnostics and emergency protection systems of power equipment. The results of the work repeatedly reported at international conferences and published in professional journals. Many of the laboratory’s innovations are protected by patents in Russia and Ukraine.

Research and Technology Development Activities

Analysis of mathematical models that describe the characteristics of rotating machinery, experimental investigations of their parameters through analysis of records of tests, as well as participate in a pilot study on the test stands and in operating conditions.

The model, describing the nature of the manifestation of the dynamics in measured vibro-acoustic parameters of the engine, is being proposed. the types of relationship between the regime parameters of machines and the parameters of the model that allows to offer a model of diagnostics of the technical condition of the engine in real time and monitor the incidence of new mechanisms of dynamics, is being established.

Specific methods of diagnosing the technical condition, taking into account the structural properties of signals and their relationship with the regime parameters of machines, are formed as the result of experimental studies using the specific examples of the techniques. During these researches, the proposed methods of diagnosing are tested and the requirements for the methods of records processing are clarified. In case of necessary, the devices that use the atypical methods of data processing are developed.

The results of the work are used to develop and to design the control systems, diagnostics and emergency protection of engines.

Fig. 1 Apparatus for control of aircraft engines.

Fig. 2 Portable apparatus for monitoring of rotary machines.

National and International Project Experience

1. Self-financing contractual works with SPA “Energy” (Moscow), “MRKS” (Moscow), Tokmak (Ukraine), “SPA Promavtomatica” (Krasnodar), “PA Engineering” Ltd. (Sarov), SDPS (Zaporozhye).

2. Participation in the INTERCOSMOS programme.

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SE Ivchenko-Progress

Department of Compressor Research

Organisation Description

State Enterprise "Ivchenko-Progress" has been designing and manufacturing aviation engines from the beginning of its foundation in 1945. The first ones were piston engines AI-26GR, AI-14R, then gas turbine engines TV-2T, AI-20, AI-24, AI-25/25TL, D-36, D-436T1/TP, D-436-148, D-18T, D-27, AI-222-25, AI-450M and other aviation engines. Some of these engines are still being manufactured today with total operating times in excess of 200 million hours.

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The Department of Compressor Research conducts design, research and certification for the following compressor types: fans of engines with high bypass ratio, axial multistage compressors, centrifugal one-stage compressors with high pressure ratio, and axial centrifugal compressors.

Research and Technology Development Activities

The Department of Compressor Research designs and tests compressors:

- One stage axial fans, multistage axial compressors of high and intermediate pressure and axial centrifugal compressors.
- High efficiency and high pressure compressors of D-18T, D-436T1/TP, D-436-148, D-27, D-36, AI-222-25 and other aviation engines.
- Small-size centrifugal compressor with high pressure ratio of AI-450M (400-470 hp) aviation engine.

National and International Project Experience

- Compressors aerodynamic projects,
- Compressor aerodynamic investigation,
- Investigation of compressor temperature condition,
- Active and passive clearance control system in compressor,
- Investigation of compressor as a part of the engine,
- Whole compressor design and tests.

European Commission, 6th Framework Programme project CESAR (Cost-Effective Small AiRcraft)
Contract no: AIP5-CT-2006-030888.

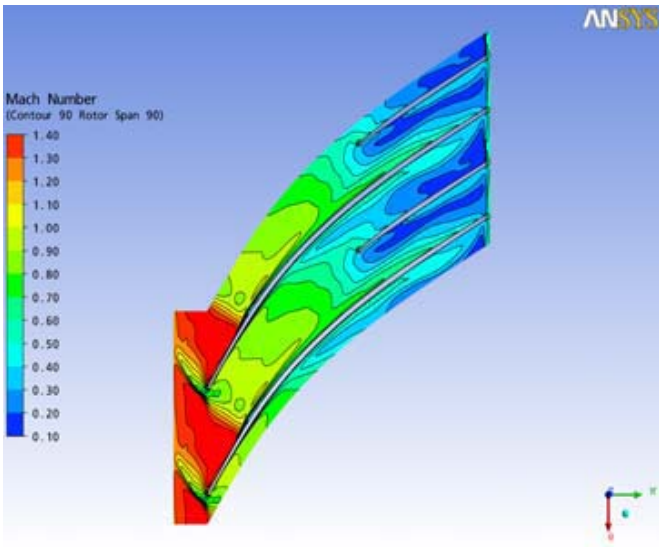

Fig. 1 Simulation of a Compression

Fig. 2 Compressor test machine

Contact Details

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SE Ivchenko-Progress

Department of Combustion Chamber Research

Organisation Description

SE Ivchenko-Progress has a wide experience in developing combustor chambers for aviation engines ranging from small-sized (rated to 450 hp) to aircraft bypass turbofan engines with a thrust of 25000 kgf. The nomenclature of combustor chambers developed at SE Ivchenko-Progress includes both forward-flow annular and return-flow designs. Each type of combustor chamber developed has past a full cycle of experimental and development works at the enterprise's test facilities.

Thanks to this fact we have received a wide range of experimental results, allowing us to develop combustor chambers meeting the environmental requirements of ICAO standards, and as for the engines D-27 (powering the An-70 aircraft) and D436-148 (powering the An-148 aircraft), having a margin of 10-20% for NOx emission level relative the ICAO-2008 standards. And with all this, the other combustor characteristics ensure reliable engine start both on the ground and in flight, and steady-state combustion under all operation conditions within the flight envelope.

For the last 20 years activities have been carried out on development and implementation of lean premixed fuel-air mixture burning technology, with fixed temperature within the burning zone, for the industrial GTE. The experience obtained can be also implemented in the combustion chambers for aircraft engines. SE Ivchenko-Progress, which is involved in designing aircraft engines for more than 60 years, has both practical knowledge and highly skilled specialists for developing pollution-free combustion chambers for aircraft engines of any size.

Research and Technology Development Activities

- Development of new low-NOx-level fuel-burning technologies.
- Ensuring burning stability.
- Increasing altitude characteristics of engine starting.
- Implementation of new temperature-resistant ceramic materials and thermal barrier coatings.
- Use of CFD for modelling combustor performance and computational prediction of main combustor's features.
- Minimization the combustor exit temperature profile.

Highly-forced annular single-row combustion chamber with single-wall fire tube and cooling system, in which most of the cooling air is used in the burning process. The fire tube dome with two-high swirlers and single-orifice nozzle with pneumatic spraying ensure good stalling characteristics 30…100. The flame igniter with lightweight ignition unit of 1J-power enables a reliable ignition when starting the engine on the ground within the whole operation range and in flight up to an altitude of 9 km.

Fig. 1 Regulated low-emission combustion chamber.

National and International Project Experience

European Commission, 6th Framework Programme project CESAR (Cost-Effective Small AiRcraft)
Contract no: AIP5-CT-2006-030888.

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SE Ivchenko-Progress

Department of Gas Dynamic Solutions and Advanced Design

Organisation Description

SE Ivchenko-Progress falls under the responsibility of the Ministry of Industrial Policy of Ukraine. The company's field of activities includes design, manufacture, certification, brining to serial production, repair and testing of aviation and industrial gas turbine engines.

SE Ivchenko-Progress is certified to develop gas turbine engines by the State Aviation Transport Department of Ukraine, Interstate Aviation Committee Aviation Register (IAC AR), "Quality" Certification Center (RF) and Bureau Veritas (France).

The Department of Gas Dynamic Solution and Advanced Design (GDS & AD) conducts scientific research and development activities for developing and analysing new engines, modifying engines and developing thermo-gas-dynamic parameters.

Research and Technology Development Activities

The activities of the Department of GDS & AD cover mainly the stage of creating a scientific-and-technology process stock for ensuring development of new engines, and the initial stage of designing new engine (conception design). Besides that the department personnel take part in experimental thermo-gas-dynamic development of new engines and preparing materials for their certification.

The stage of creating a scientific-and-technology process stock includes the following: exploration and prognostication of aeronautical engineering market demands, generation of ideas, searching ways of realization, working out new technologies and analyzing the possibility for using available ones, revelation of main parameters and design appearance of engine, experimental working off of new components and units, development of preliminary design (technical proposals), and, if required, manufacturing and testing a demonstrator unit.

National and International Project Experience

1. Aeronautical Scientific/Technical Complex ASTC, Kyiv, Ukraine – engines for An-124, An-225, An-140, An-148, An-70 aircraft.

2. Motor Sich JSC, Zaporozhye, Ukraine – TV3-117VMA-SBM1, D-436T1/TP/148, AI-450, AI-450MS, D-27, AI-222-25, AI-436T12, SPM-21 engines;

3. Institute of machine-building problems of NAS of Ukraine, Engineering Academy of Ukraine, Kharkiv, Ukraine – program complex for multilevel, multicriterion optimization of engine parameters;

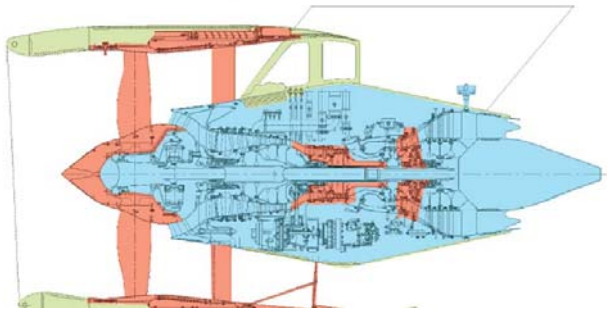

Fig. 1 Advanced engine layout

Fig. 2 Swept wide chord low-noise fan

4. National Aerospace University «Kharkiv Aviation Institute», NAU «KhAI», Kharkiv, Ukraine – Development of aircraft GTE dynamic mathematical models.

5. IRKUT Corporation, Moscow, Russia – D-436T12, SPM-21 engines projects;

6. Federal State Unitary Enterprise SALUT MMPP, Moscow, Russia – AI-222-25, D-436T12, SPM-21 engines projects;

7. European Commission, 6th Framework Programme project CESAR (Cost-Effective Small AiRcraft), Contract no: AIP5-CT-2006-030888.

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SE Ivchenko-Progress

Department of Electronic Control & Monitoring Systems

Organisation Description

State Enterprise "Ivchenko-Progress" has been designing and manufacturing aviation engines from the beginning of its foundation in 1945. The first ones were piston engines AI-26GR, AI-14R, then gas turbine engines TV-2T, AI-20, AI-24, AI-25/25TL, D-36, D-436T1/TP, D-436-148, D-18T, D-27, AI-222-25, AI-450M and other aviation engines. Some of these engines are still being manufactured today with total operating times in excess of 200 million hours.

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Research and Technology Development Activities

The department's main activities cover the development and testing of the following systems:

a) Automatic control systems: Electronic control systems; fuel systems; pneumatic systems; hydro-mechanical systems; test and control equipment; bench (technological) control systems; and benches of in-line simulation.

b) Monitoring and diagnostic systems: On-board; on-ground; monitoring systems of vibrations; systems of representation of parameters and signals of the engine.

c) Measuring systems.

d) Electric equipment.

Integrated diagnostics and on-condition maintenance, reduction of operational costs, pilots and ground crew workload and safety improvement. Integration of on-board diagnostic/monitoring and maintenance support systems into the single maintenance system with high efficiency and accuracy of prediction and with minimum human intervention allowing for "on-condition" maintenance and higher operational reliability.

National and International Project Experience

Research and technology development experience while designing electronic control & monitoring systems for the following engines: D-18T, D-436T1, D-436TP, D-436-148, D-27, AI-22, AI-450 and AI-222-25.

1. Aeronautical Scientific/Technical Complex "Antonov" ASTC, Kyiv, Ukraine: An-124, An-225, An-140, An-148, An-70 aircraft projects

2. National Aerospace University «Kharkiv Aviation Institute», NAU «KhAI», Kharkiv, Ukraine – Development mathematical models for monitoring engine.

3. European Commission, 6th Framework Programme project CESAR (Cost-Effective Small AiRcraft), Contract no: AIP5-CT-2006-030888.

4. European Commission, 7th Framework Programme project Aero-Ukraine, Contract no: ACS8-GA-2009-233640.

5. AVIC (HONGDU) L15, AI-222-25K (F) engine projects.

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SE Ivchenko-Progress

Department of Reduction Gearbox

Organisation Description

State Enterprise "Ivchenko-Progress" has been designing and manufacturing aviation engines from the beginning of its foundation in 1945. The first ones were piston engines AI-26GR, AI-14R, then gas turbine engines TV-2T, AI-20, AI-24, AI-25/25TL, D-36, D-436T1/TP, D-436-148, D-18T, D-27, AI-222-25, AI-450M and other aviation engines. Some of these engines are still being manufactured today with total operating times in excess of 200 million hours.

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Since the 1990s, SE Ivchenko-Progress has developed and started serial production of reduction gearboxes of electric power stations of 2500 kW and 6000 kW. The operating time for some gearboxes has reached 30000 hours without repair. Since 2000, SE Ivchenko-Progress has been working on helicopter transmissions. Today, main and tail reduction gearboxes are serially manufactured for the light helicopters KT-112 and AK-1-3.

Research and Technology Development Activities

An aviation reduction gearbox should operate “precisely under load” because its parts must work specifically under heavy loads. It means that reliable work of gear meshings should be provided at elastic deformation of construction units, including teeth, under the influence of internal and superposed forces. According to this aim, after selection of a basic rack profile and a module of teeth, optimized on weight and strength, optimization of the longitudinal and profile modifications is conducted using programmes specially developed by SE Ivchenko-Progress.

In order to calculate modifications, besides accounting deformations of teeth, it is necessary to consider deformations of cases and bearing supports. That is provided with three-dimensional calculations of displacements and strains in parts carried out by means of the programme ANSYS.

In order to increase the contact durability of gear teeth, the department developed an antifriction coating. Research results have indicated the coating increases durability by up to 40%. It has now been implemented on reduction gearboxes for the aircraft engines AI-450, D-27 and TV3-117VMA-SBM1.

Fig. 1 Prop-fan engine D-27

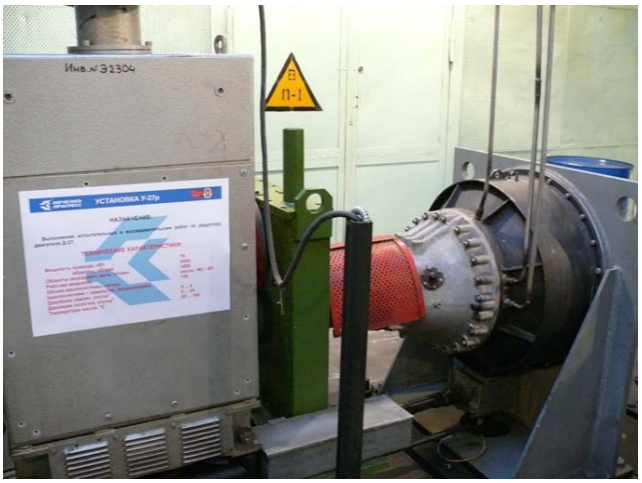

Fig. 2 Test-and-development rig for bearings, satellites and sealings.

National and International Project Experience

1. Aeronautical Scientific/Technical Complex “Antonov” ASTC, Kyiv, Ukraine - D-27, TV3-117VMA-SBM1 engine projects;
2. “Motor-Sich” JSC, Zaporozhye, Ukraine – TV3-117VMA-SBM1 engine project.
3. Scientific & Production Enterprise “Aerosila”, Moskow, Russia- D-27, TV3-117VMA-SBM1 engine projects;
4. Federal State Unitary Enterprise “MMPP Salut”, Moskow, Russia – D-27 engine project;
5. Central Institute of Aviation Motor-Building, Moskow, Russia;

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SE Ivchenko-Progress
Department of Turbine Research

Organisation Description

State Enterprise "Ivchenko-Progress" has been designing and manufacturing aviation engines from the beginning of its foundation in 1945. The first ones were piston engines AI-26GR, AI-14R, then gas turbine engines TV-2T, AI-20, AI-24, AI-25/25TL, D-36, D-436T1/TP, D-436-148, D-18T, D-27, AI-222-25, AI-450M and other aviation engines. Some of these engines are still being manufactured today with total operating times in excess of 200 million hours.

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Since the 1990s, SE Ivchenko-Progress has developed and started serial production of reduction gearboxes of electric power stations of 2500 kW and 6000 kW. The operating time for some gearboxes has reached 30000 hours without repair. Since 2000, SE Ivchenko-Progress has been working on helicopter transmissions. Today, main and tail reduction gearboxes are serially manufactured for the light helicopters KT-112 and AK-1-3.

The turbine research department designs and tests the following types of turbines:

- One stage, multistage, cooled, uncooled for aeroengines.
- High temperature efficient turbines` of D-18T,D-436T1/TP,D-436-148,D-27, D-36,AI-222-25 and other aviation engines.
- Small-size high pressure, cooling/power contra rotating turbines of AI-450M (400-470 hp) aviation engine.

Research and Technology Development Activities

Turbines aerodynamic projects, CFD calculations, aerodynamic tests, turbine blades/rotor cooling investigations, thermal tests, active clearance control system in turbine, whole turbine design and tests.

National and International Project Experience

European Commission, 6th Framework Programme project CESAR (Cost-Effective Small AiRcraft) Contract no: AIP5-CT-2006-030888.

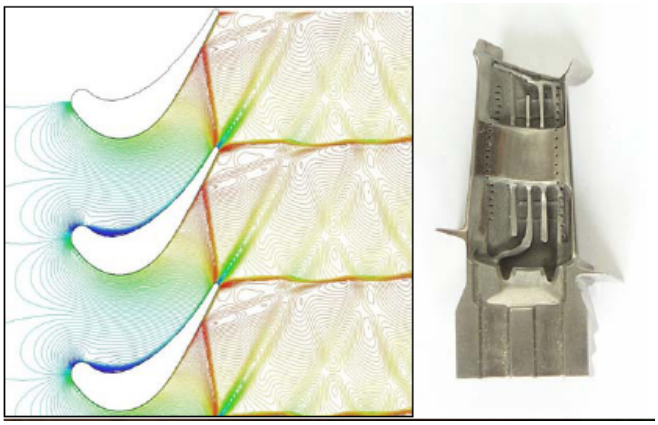

Fig. 1 Fluid mechanic simulation.

Fig. 2 Example turbine

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SE Ivchenko-Progress
Department of Strength

Organisation Description

SE Ivchenko-Progress falls under the responsibility of the Ministry of Industrial Policy of Ukraine. The company's field of activities includes design, manufacture, certification, brining to serial production, repair and testing of aviation and industrial gas turbine engines.

SE Ivchenko-Progress is certified to develop gas turbine engines by the State Aviation Transport Department of Ukraine, Interstate Aviation Committee Aviation Register (IAC AR), "Quality" Certification Center (RF) and Bureau Veritas (France).

The Department of Gas Dynamic Solution and Advanced Design (GDS & AD) conducts scientific research and development activities for developing and analysing new engines, modifying engines and developing thermo-gas-dynamic parameters.

Research and Technology Development Activities

For the past 15 years, the Department of Strength has conducted theoretical and experimental studies to ensure the strength and service life of the following engines:

- D-436T1,
- D-436TP,
- D-436-148,
- D-18T, D-27,
- TV3-117VMA-SBM1.

The engines were subjected to four basic failure mechanisms: short-term strength, long-term strength, high-cycle fatigue and low cycle fatigue. The service life of aero-engine components is established according to experiments carried out with prototype parts and computer simulations.

National and International Project Experience

1. "Motor-Sich" JSC, Zaporozhye, Ukraine.
2. N.E. Zhukovsky National Aerospace University (KhAI), Kharkiv, Ukraine.
3. G.S. Pisarenko Institute of Strength Problems of NASU, Kyiv, Ukraine.
4. A.N. Podgorny Institute of Mechanical Engineering Problems of NASU, Kharkiv, Ukraine.
5. Central Institute of Aviation Motor-Building, Moscow, Russia.
6. Technische Universitat Munchen, Institute of Energy Systems (IES), Munchen, Germany, CESAR project (FP6).
7. VZLU - Vyzkumny a zkusebni letecky ustav, a.s. Aeronautical Research and Test Institute Praha, Czech Republic, CESAR project (FP6).

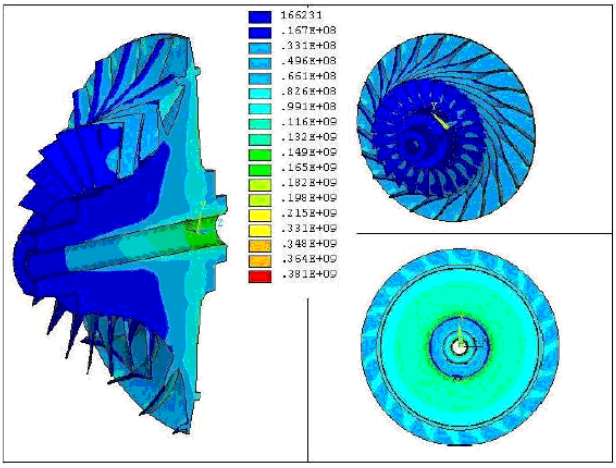
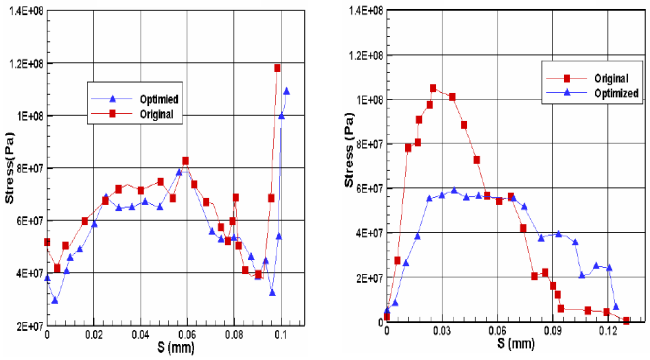


Fig.1 Distribution of stresses (Pa) in optimized impeller



a b

Fig. 2 Distribution of stresses in impeller blades

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Scientific and Technical Enterprise "TDM"

Organisation Description

Scientific and Technical Enterprise “TDM” was founded in 1992 and is engaged in the study of semiconductor materials and the development of measuring sensors. The company has carried out several research contracts with the D.V.Efremova Scientific Research Institute of Electrophysical (Russia) to develop semiconductor sensors for temperature, mechanical tensions and magnetic fields measurements for a wide range of temperature and hard environmental conditions. These sensors have been used for navigation, guidance and target designation systems at the superconducting facility “Phoenix” in Kyiv.

Today, TDM conducts R&D on semiconductor properties and sensors and analyses their characteristics. We are able to measure sensors characteristics at room and liquid nitrogen temperature. Some aspects of sensor and semiconductor material production as well as complex sensor tests are conducted in collaboration with Ukrainian and Russian partners.

Research and Technology Development Activities

TDM develops semiconductor sensors for temperature (thermo-resistors), mechanical tension (tenzoresistors, strain sensors) and magnetic field (Hall sensors) measurements across a wide temperature range 4,2 – 400 K. Our sensors are small: Hall sensors – 1x1x0,5 mm, strain sensors – 1x8x0,4 mm, and thermo-resistors – 1x1x1 mm. They have high measurement sensitivity: for temperature up to – 100%/K, for magnetic field – up to 500 mV/Tl, and for mechanical tensions – up to 100 mkV/mln^{-1}.

TDM employees are authors of numerous sensor related patents including:

- Patent R. F. 2043671. Semiconductor tenzoresistors. Auth. Gorbachuk N.T. / B.I. 1995, № 25;
- Patent R.F. 2025736. Method of measuring of temperature. Auth. Gorbachuk N.T. / B.I. 1994, №24;
- Patent R.F. 2001115570. Single-component primary transformer, single-component sensor, three-component primary transformer and three-component sensor of magnetic field, workings on Hall effect. Auth. Gorbachuk N.T., Zhelamskiy M.V., Konstantinov A.B., Sychevskiy S.E., Filatov O.G., publ. 20.08.03.

TDM is keen to collaborate with international partners in the following R&D areas:

- Development and production of sensors with customer predefined physical parameters;
- Improvement of previously developed sensors according to customer requirements;
- Improvement of sensors technical characteristics, technologies of production and measuring, and reduction of production costs, etc.

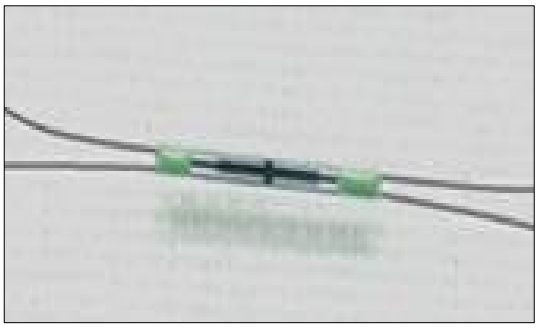

Fig. 1 Mechanical tension sensor

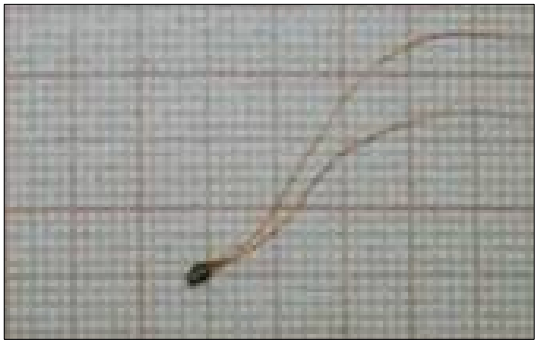

Fig. 2 Temperature sensor

National and International Project Experience

TDM executed the following R&D works for Scientific Research Institute of Electrophysical Apparatus named after D.V.Efremov (St.-Petersburg, Russia):

- Development and manufacturing of the complete set of diagnostic gauges for carrying out of tests on the plant "PHOENIX". Kyiv, 1994.
- Development, manufacturing and testing of a working set of gauges of a magnetic field for breadboard model AKP/SP. Kyiv, 2000.

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Southern National Design & Research Institute of Aerospace Industries "YUZHGIPRONIIAVIAPROM"

Organisation Description

The Southern National Design & Research Institute of Aerospace Industries ("YUZHGIPRONIIAVIAPROM") has been the leading enterprise for developing, constructing and modernising airports and aviation facilities in Ukraine since 1940.

It has 115 staff including 90 engineers. The Institute has departments for Process, Masterplan, Architectural, Civil, Sanitary and Electrical Engineering; as well as laboratories for civil structural surveys, field surveys; dwelling architectural studio. The organisation has ISO 9001:2000 quality assurance certification.

Research and Technology Development Activities

- Deep & comprehensive turnkey engineering for the aircraft building & repair enterprises.
- Comprehensive design projects for airfields, airports, heliports, and infrastructure facilities.
- Comprehensive design projects for aviation hangars.
- Civil/Structural/Architectural design for civil & dwelling purposes.
- Different kinds of power facilities & network design.
- Multipurpose soil & topo engineering surveys for construction purposes.
- Condition structural surveys for buildings and constructions being actually available.

National and International Project Experience

1) Joint International projects: Process engineering section for An-140-100 aircraft pre-production project including engines thereof within the scopes of international contracts with Antonov ASTC and Motor Sich JSC concluded with Iran authorities (1997-2005); a project for helicopter engines overhauling process line in Algeria (2001-2003).

2) Projects in Russia: Voronezh Aircraft Building Plant (VASO); ROSTVERTOL (Rostov, Russia); ALCOA Metallurgy Rus Inc. (Belaya Kalitva, Rostov Province, Russia).

3) Projects within Ukraine: SE Ivchenko-Progress Design Bureau Enterprise, Zaporozhye, Ukraine; Motor Sich JSC, Zaporozhye, Ukraine; Kharkiv State Aircraft Manufacturing Company (KSAMC), Kharkiv, Ukraine; Volchansk Aggregate Plant, Volchansk, Kharkiv Province, Ukraine; Ukrainian State Air Traffic Service Enterprise (UkSATSE); Directorate for Donetsk International Airport capital development & renovation, Municipal Ent.; and CENTERAVIA LLC.

Fig. 1 Service centre for Antonov planes

Fig. 2 Air traffic control tower

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Ternopil Ivan Pul'uj State Technical University
Department of Mechanical Engineering

Organisation Description

Ternopil State Ivan Pul'uj Technical University (TSTU) was founded in 1961. The university is a full member of the European Association of Universities (since 1999) and Bologna Charter of Universities (since 1995). The university has 8 departments including Mechanical Engineering Department; Electrical Engineering Department; Testing Instruments and Radio Computer Systems Department; Computer Technologies Department; and Electronic Apparatuses and Computer Systems Department. The university has over 9800 students.

Research and Technology Development Activities

The Mechanical Engineering Department's main research activities comprise:

- Structural integrity assessment of the construction elements and microstructural aspects of the fracture processes;
- new materials development and their production technologies;
- equipment and installations for machine-building;
- equipment and installations for radio engineering;
- equipment and installations for food and food processing industries and agriculture;
- biotechnical and medical apparatus and devices;
- new technologies of parts surfacing;
- electrical engineering systems and illuminating engineering.

The Dept's technology development activities comprise:

- the control of antenna system for the earth remote sensing;
- Power supply on magnetic switches;
- Multichannels switch mode power supplies;
- Switch Mode Power Supply for Radio Stations of the Railway Transport;
- Electronic Starting Controllers of New Generation for Luminescent Lamps;
- The system for ophthalmo-diagnostics.

The Dept is keen to collaborate with international partners in the following areas:

- Lifetime assessment of high-loaded structural elements of a wing of transport airplane;
- Stress-strain state analysis using FEM;
- An automation grid method to measure surface strain of materials and structural elements;
- Characterization of materials and components under static and dynamic loads;
- TEM studies of the microstructure of materials;
- SEM studies of the microstructure and fracture micromechanisms of materials;
- Certification and study of material chemical composition;
- Assessment of geometrical characteristics of surface crack networks using computational analysis of digital images.

Fig. 1 Structural analysis

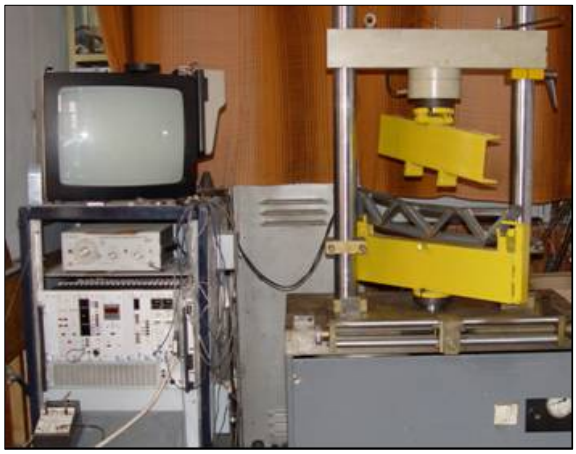

Fig. 2 Structural testing

National and International Project Experience

Ukrainian projects: "The influence of temperature and waveform of loading on fatigue crack growth rate of materials of continuous casting machines rolls" (State Fund for Fundamental Investigations) and "Crack growth modelling in the construction elements of the transport plane wing under irregular loading" (Ministry of Educations and Science);

European Commission projects: "Plant life assessment network in Central and Eastern European countries" (ERB IC15 CT98 0813, INCO);

Ukrainian-Slovenian joint projects (with University of Maribor): "Vikers indentation as a model of micro-defect" (2004-2006); "Crack resistance of weld of heat-resistance steels at thermal cyclic loading" (2006-2008); and "Application of the deterministic and statistic approaches to the estimation of the residual durability of structures" (ongoing project).

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V. Bakul Institute for Superhard Materials of the National Academy of Sciences of Ukraine
Department of Resource-Saving Technologies of Machining with Superhard Materials Tools

Organisation Description

The V. Bakul Institute for Superhard Materials of the National Academy of Sciences of Ukraine is a highly regarded research centre. It conducts research on novel mono- and polycrystalline superhard materials: synthetic diamonds, cubic boron nitride, composites and ceramics. These superhard materials are widely used in the tool industry for machining metal and non-metal materials. They are also used for structural elements in instrument-making, electrical industry, space equipment, optics, and electronics.

The institute has 420 employees including 38 doctors, 81 candidates of sciences, and over 100 young researchers and post-graduate students. The institute works fruitfully with a number of Ukrainian enterprises including Antonov ASTC.

Research and Technology Development Activities

The Institute's RTD activities include:

- studies about high-pressure effects on materials and use of high pressures in production processes;
- investigations into physicochemical processes of making monocrystalline, dispersed, and film-like superhard materials over a wide range of temperatures and pressures;
- development of new production technologies for nanopowders, ceramic and composite materials, and products of them;
- development of efficient processes of machining metals and non-metallic materials with superhard materials (SHM) tools;
- studies on thermodynamics and kinetics of contact interactions between SHM tools and work pieces of metals, ceramics and other materials to extend the SHM applications in basic branches of industry;
- elaboration of methods, processes and tools for cold plastic deformation of titanium and its alloys:
  - development of lubricants for machining titanium alloys by intensive cold plastic deformation;
  - development of technological processes of volume and surface cold plastic deformation of titanium alloys;
  - development of technological processes of the formation of gradient structures containing nano- and fine-dispersed deformation-caused structures in a titanium alloy surface layer.

The institute offers the following services:

- development and manufacture of tools for cutting and plastic deformation of titanium alloys;
- elaboration of metal- and energy-saving technological processes;
- manufacture of return bends for pneumo- and hydro-pipelines and high-pressure systems.
- elaboration of methods to improve an adhesion inactivity and wear resistance of titanium alloys in friction pairs

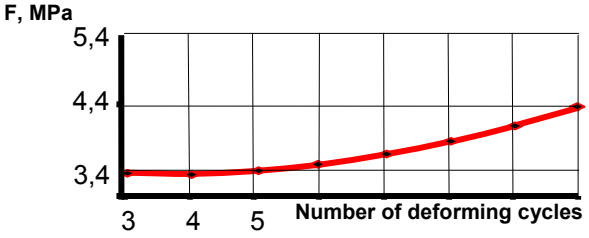

Fig. 1 Specific friction force of the hard lubricant at contact pressure of 2.2 GPa in cold plastic deformation of titanium alloy. F, MPa a number of deforming cycles

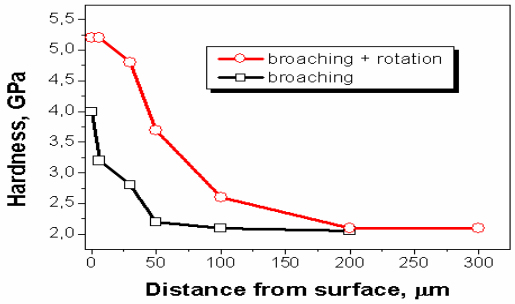

Fig. 2 Microhardness of a BT 1-0 titanium surface layer after deform broaching

National and International Project Experience

INTAS 93-3633 Improvement and testing of hard materials/tool materials used for cutting procedures

STCU 3596 Influence of Anisotropy of Crystal Lattice on Workability and Quality of Medical Sapphire Implants

STCU 4596 Development of methods for hardening of sapphire used in medicine

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Zaporozhye National Technical University
Machine Building Institute

Organisation Description

Zaporozhye National Technical University consists of 7 institutes, 5 colleges, 14 faculties and over 16,000 students. The university has scientific schools involved in foundry technology, material science, thermal treatment, welding processes, radio technics, microelectronics, mechanics of dynamical systems, and technical cybernetics. There are 4 science-technical magazines published in the university.

Since 2000, specialist training has been provided about technology for aviation engine production. Modern technologies, licensed commercial programme packages and special software are used in the educational process. Close working and education relations exist with factories in Zaporozhye.

Research and Technology Development Activities

Research staff develop innovative technologies to increase efficiency and quality of aviation engine production. Application of our developed technologies has enabled production rates to be increased by 50 – 55% for aviation blades, shafts and disks.

We offer the following technologies and services:

- optimization of manufacturing techniques for the basic details of aviation engines;
- optimization of modes of high-speed milling of shovels for compressors;
- optimization of modes of hardening of surface layers;
- calculation of the intense-deformed condition of details of aviation engines;
- tests for wear of samples and natural details of aviation engines at working temperatures;
- formation of a sub-microcrystalline condition in preparation of details of aviation engines.

National and International Project Experience

Ministry of Education and Science projects:

1. Working out of technology of formation nanostructures in a surface layer of details of aviation engines for maintenance of their reliability and a resource
2. Working out of technological basis of maintenance of quality of processing of non-rigid details for high-speed milling
3. Working out and research of titanic alloys in nanostructured condition for aviation technics

Motor Sich JSC projects:

1. Research and working out of integrated manufacturing techniques for blings of a compressor for the high pressure turbojet engine D-27
2. Research of influence of technology twist extrusion on constructional durability of titanic alloys for working blades of compressors

Fig. 1 Equipment for hardening of bling blades

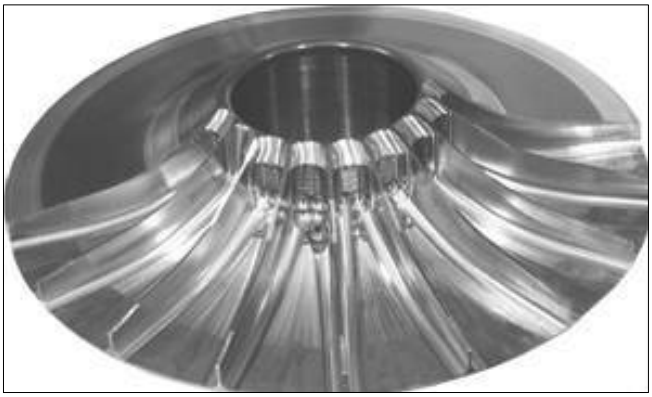

Fig. 2 Sample for milling of bling blades

1. Working out and research of methods of increase of bearing capacity of working blades aircraft engines of new generation
2. Working out and research of complex form-building manufacturing techniques of the centrifugal wheel of the compressor of auxiliary power-plant АИ-450МС
3. Research, ordering, choice and research of progressive manufacturing techniques of basic details aircrafts engines of new generation

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