



National Aerospace University “KhAI”

Aeronautic related researches overview

Kharkiv, Ukraine

Lina Smovziuk

International S&T Programs manager

Who we are:

National Aerospace University «KhAI»

- 1930 - founded as Kharkiv Aviation Institute
- 1998 - Aerospace University
- 2000 - National Aerospace University



National Aerospace University «KhAI»:

- 12000 students
- 250 postgraduates
- 800 teachers (430 Ph.D., 95 D.Sc.)
- 2000 employees
- 10 Faculties
- 27 Specialities
- 45 departments
- terr. 25 hectares



International Activity:



About 800
students from
60 countries

Research collaboration

- United Kingdom
- Germany
- France
- Finland
- United States
- Mexico
- South Korea
- China
- Japan
- Austria
- Sweden



EU Research Projects:

- **FP6 – SENARIO** (Advanced Sensors and Novel Concepts for Intelligent and Reliable Processing in Bonded Repairs) – 11 members Consortium
- **FP6 – ALCAS** (Advanced Low Cost Aircraft Structures) – 61 members Consortium
- **FP7 - HPH.com** (Helicon Plasma Hydrazine Combined Micro Engine) – 15 members Consortium
- **FP7 – AERO-UKRAINE** (Support actions for further cooperation EU/Ukraine aeronautic communities)

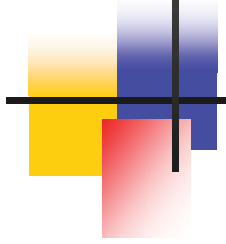


EU TEMPUS projects:

- Tempus JEP 26212-2005 “Promoting Excellence in Aerospace Engineering” (2006-2008)
- Tempus JEP 26008-2005 “MSc and PhD Studies in Aerospace Critical Computing” (2006-2009)
- Tempus JEP 27201-2006 “Introducing EU-compatible MSc degree in Engines and Aircraft Power Systems” (2007-2009)
- Tempus JEP 27300-2006 “Logistics for aviation engineering: Curriculum and Training Center”

AeroHydroDynamics Lab:

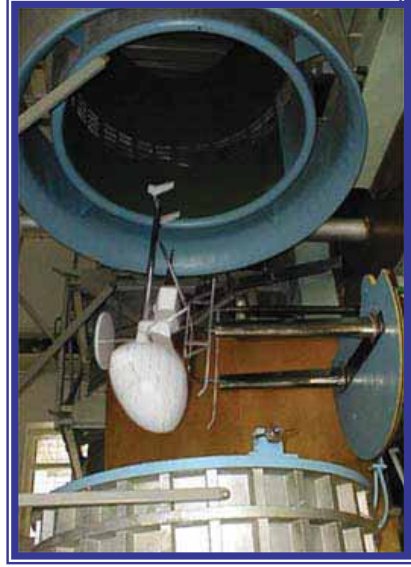
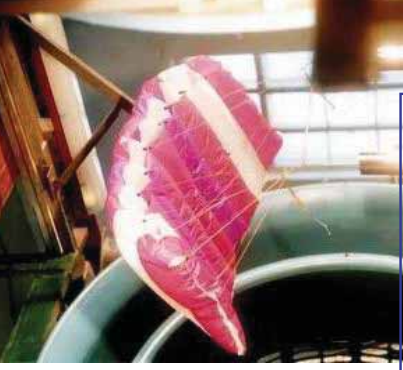
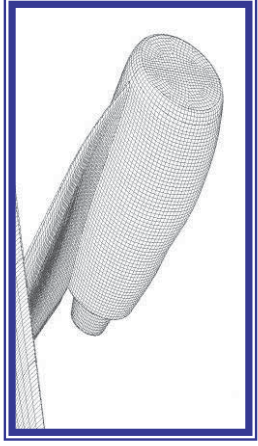
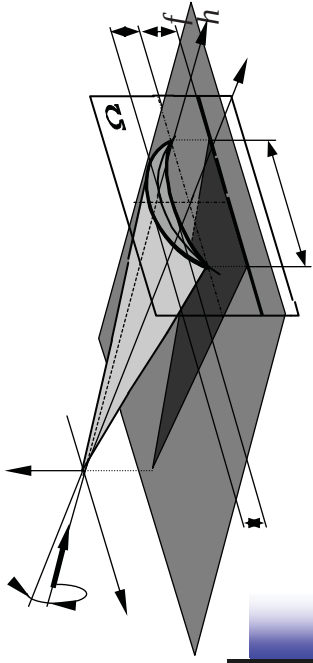
Subsonic and supersonic aerodynamics



Unique aerodynamic complex consisting of six wind tunnels, including the supersonic one with the Mach number of 1 to 4



Aerodynamic Simulation and Wind tunnel tests



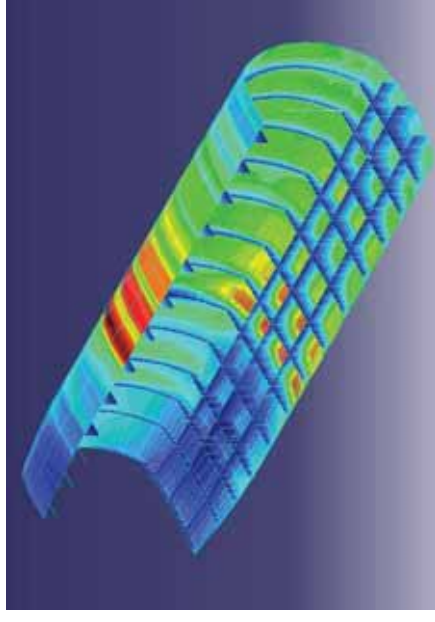
Strength Lab:

Static and fatigue test facilities

- Static and fatigue characteristics of materials
- FEM analysis
- Airframes durability definition

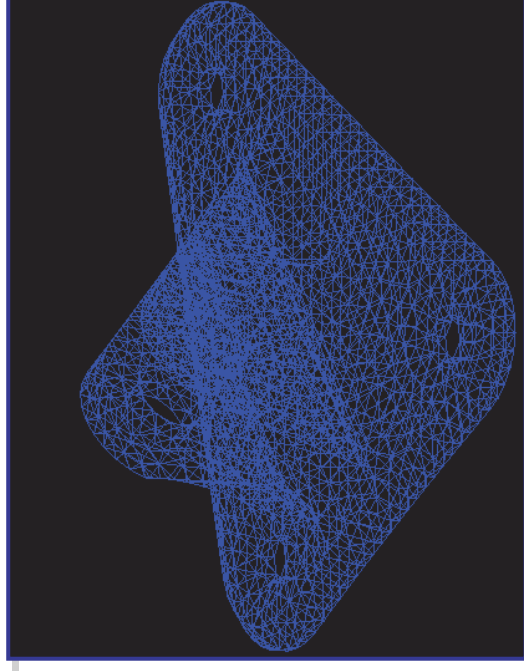
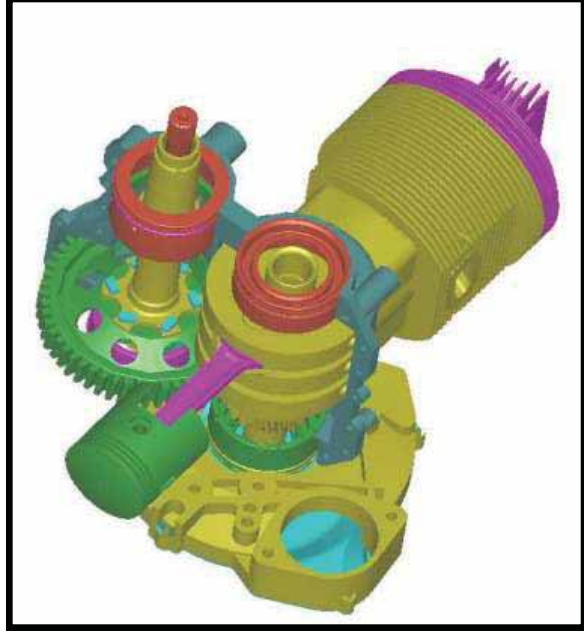
Certified:

- Aviation Regulations of Ukraine, part 23, sections C and D.
- Airworthiness Specifications JAR-VLA, sections C and D.



Design Centre: **CAD / CAM / CAE**

UNIGRAPHX, EUCLID, ANSYS,
NASTRAN, COSMOS, SOLID
WORKS, LS DYNA etc.
Design, 3D models, FEM



Unmanned Aerial Vehicles (UAV)



UAV Civil Application Projects

(1-st Ukrainian Innovation Competition Winner)



INSPECTOR

Oil/gas pipelines monitoring

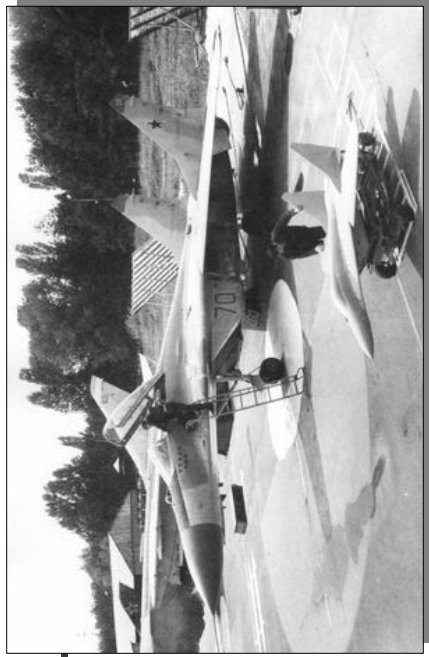
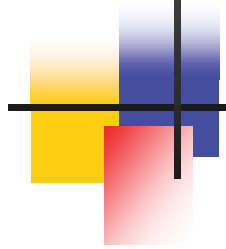


GyroBee

Precision agriculture:

- crops monitoring
- chemical treatment

Supercritical Flight Tests with Free-flying models

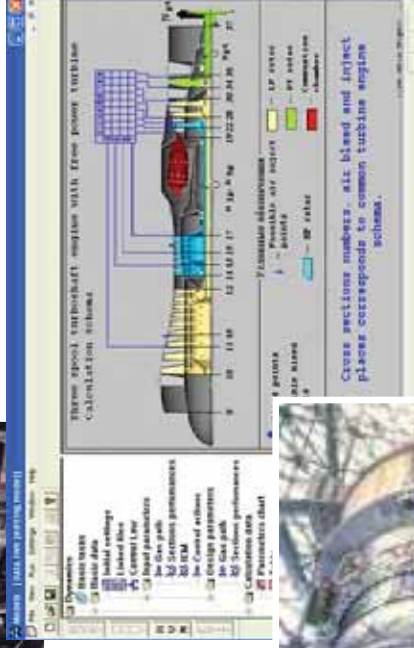


Aircraft engine research

Simulation and testing of
gas-dynamic processes
in gas-turbine engines.
Joint projects with KIMM
(Korea)

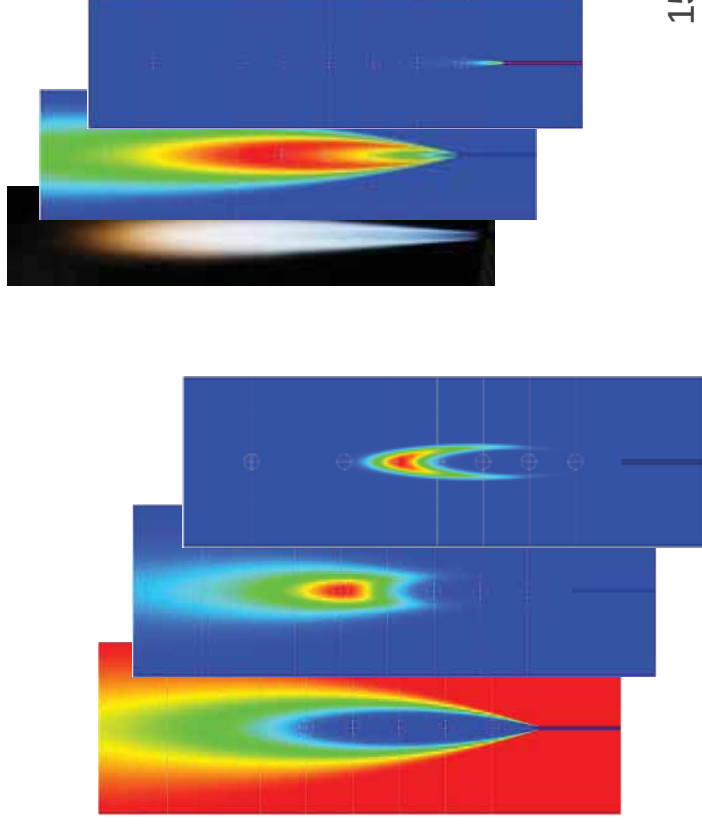
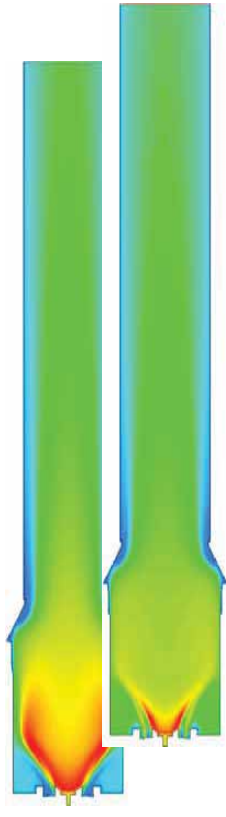
Real-time diagnostics of
gas-turbine engines.
Commercial application
by CCC (USA).

Engine control
simulation software



Green engine: emissions decreasing

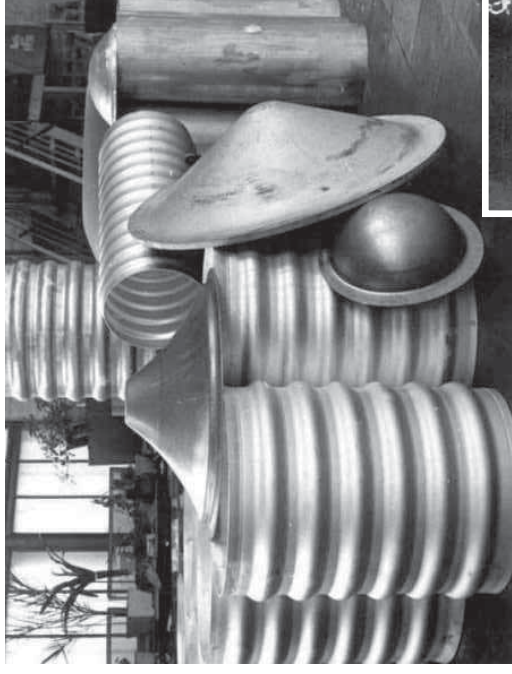
- **alternative fuels
(hydrogen, biofuels
and synthetic fuels)**
- **engine exhaust
composition modeling
tools development**
- **combustor innovative
design to reduce the
environmental impact
(NOX, CO, CO₂, etc.)**



High-speed forming and cutting technology: explosive, electro-hydraulic

(STCU P326 project with DoE, Ford, and PNNL)

- Aviation engines parts of complex 3D geometry
- Large dimensions ship parts
- Automotive parts of advanced alloys
- Continuous casting metal cutting

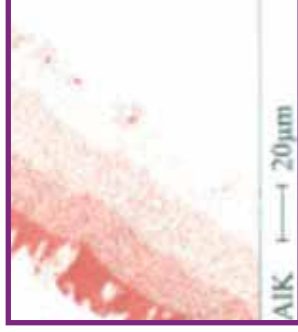
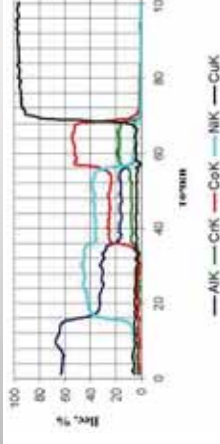


**US Pat.
4,020,663
3,518,860**



Coating technology

Multi-layer nano-scaled coatings



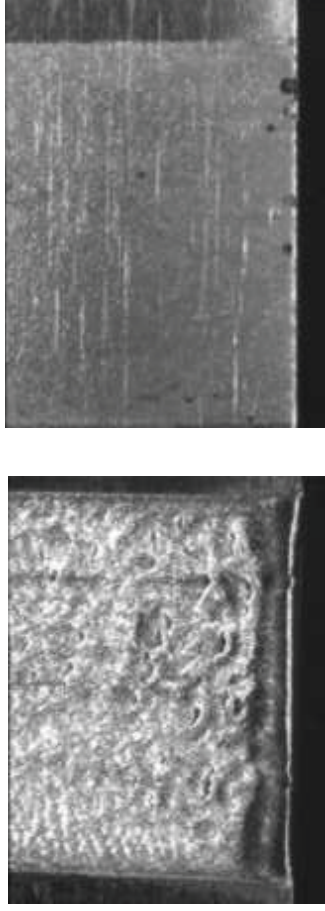
- Erosion-resistant
- TBC
- Photo chromic
- Hardening

Metal-nanodiamond electroplating coating

(Joint research with SINTA Ltd., Ukraine and DKI, Germany)



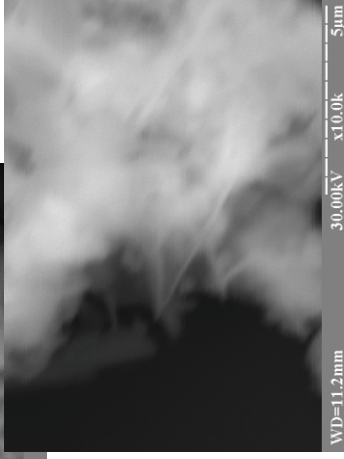
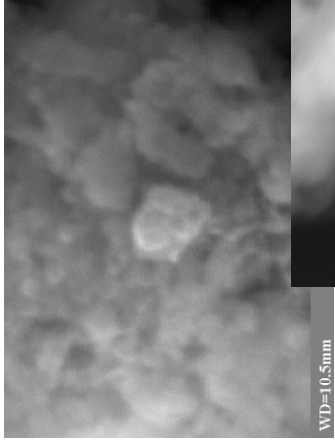
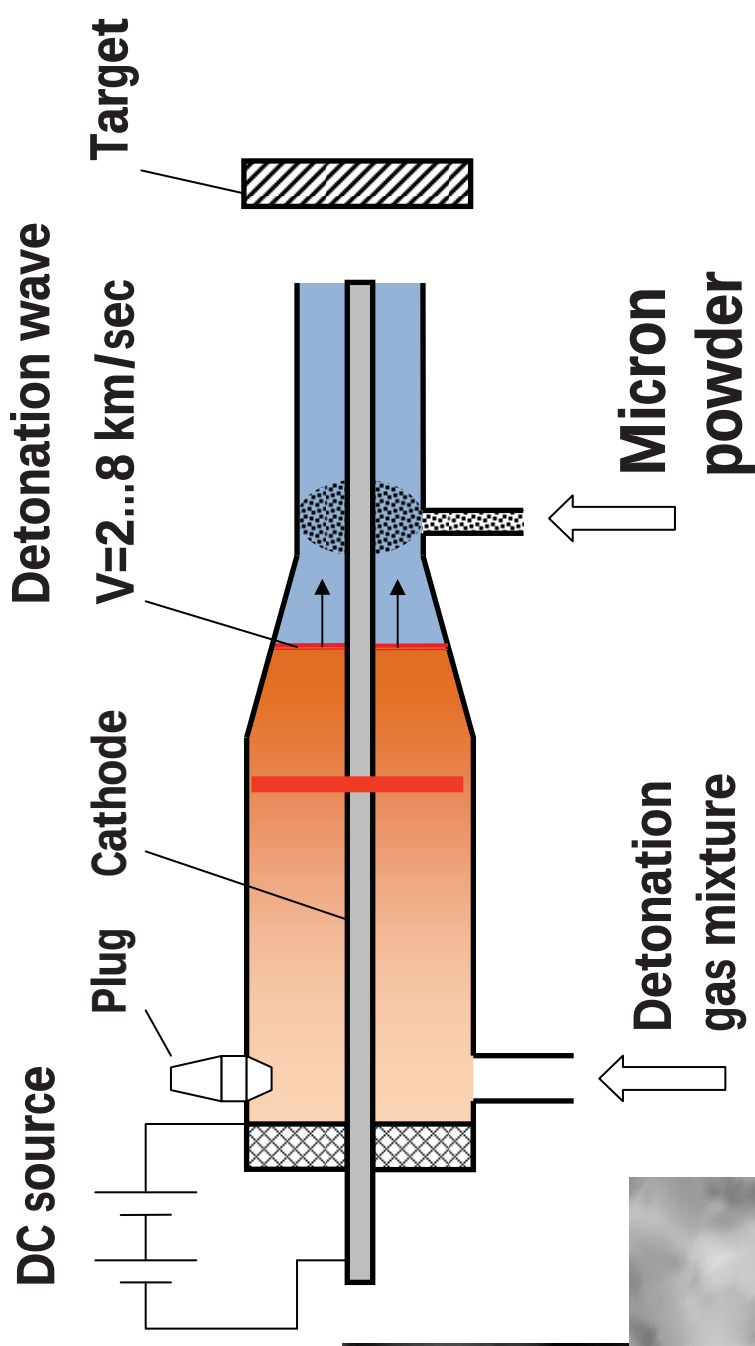
- Sufficient (3-8 times) parts lifetime increasing = operational cost decreasing
- Lower coating thickness = sufficient Cr economy = manufacturing cost decreasing
- Plating line productivity increasing = manufacturing cost/time decreasing
- Lower Cr consumption = environmental benefits



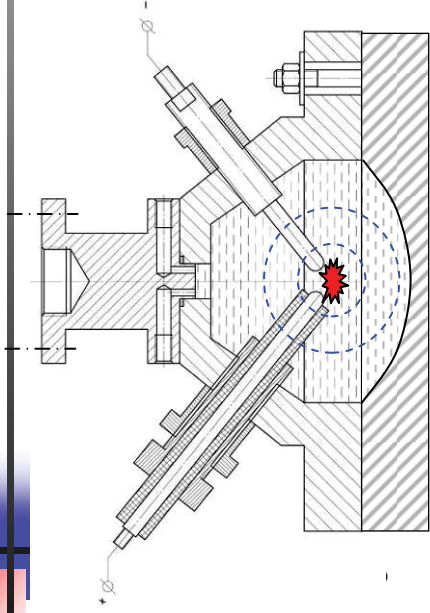
Plastic injection feed screw

Low cost nano-powders gas-detonation manufacturing technology

(Presented at TechConnect 2009, Houston)

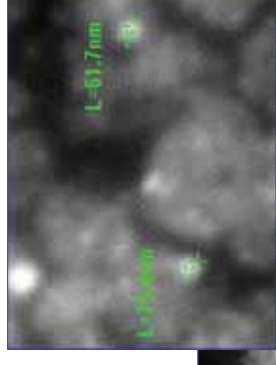
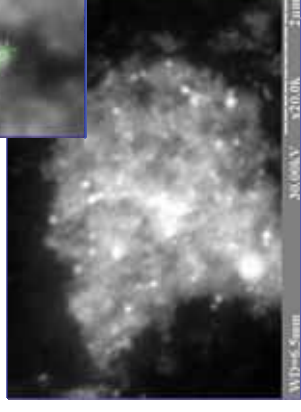
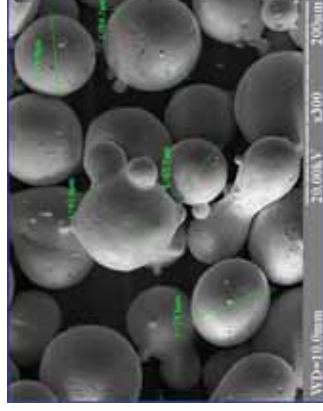


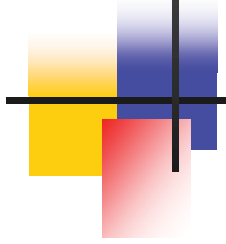
Electro-hydraulic nano-powders manufacturing technology



High-voltage discharge in a liquid – acting disintegration factors:

- high-intensity electric field
- high temperature
- high pulse pressure
- cavitations





Industrial Plasma torch prototype



Working current
2 KA (1-st stage)
20 KA (2-d stage)
Planned lifetime 3000 hours

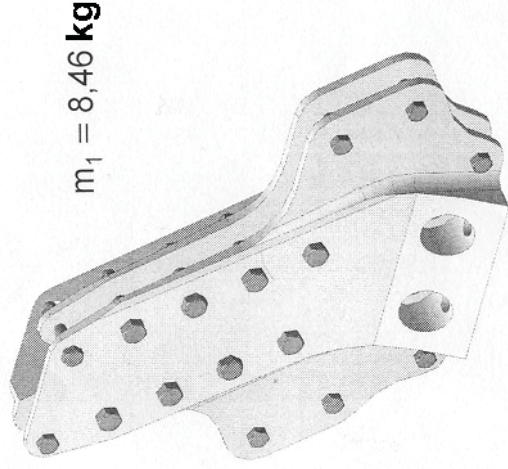
Heterogeneous Composite-to-Composite and Composite-to-Metal heavy-loaded joints

(STCU P296 project with EOARD)



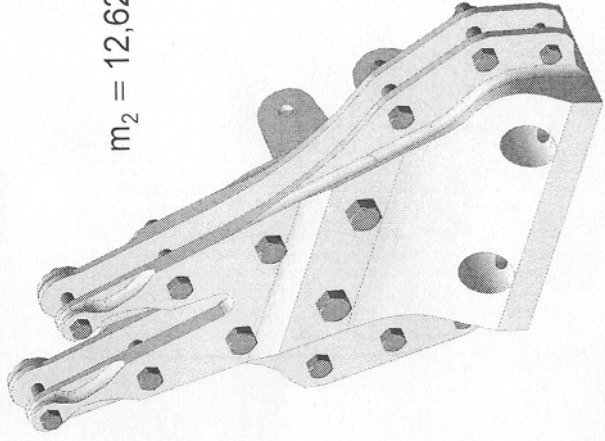
Examples of joints with transverse microfasteners

Practical Results:



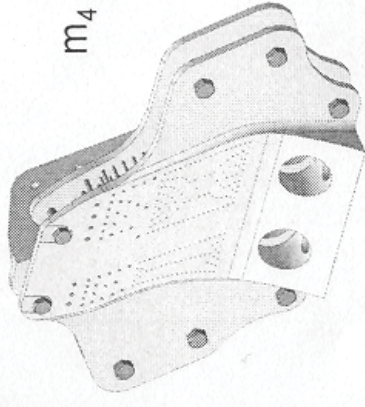
$m_1 = 8,46 \text{ kg}$

Existing cargo
aircraft fin
fitting



$m_2 = 12,62 \text{ kg}$

Manufacturer's
re-design



$m_4 = 5,65 \text{ kg}$

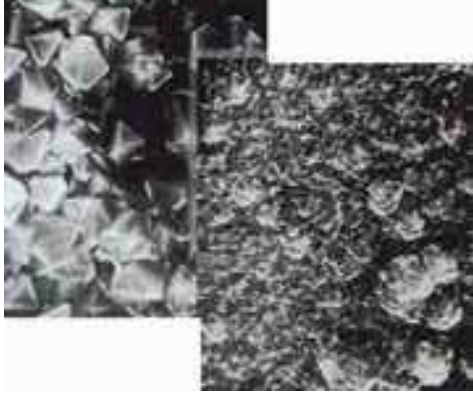
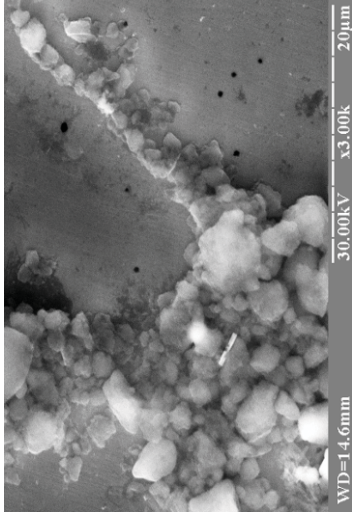
Re-design using
micro-fasteners

**Weight
saving
33%**

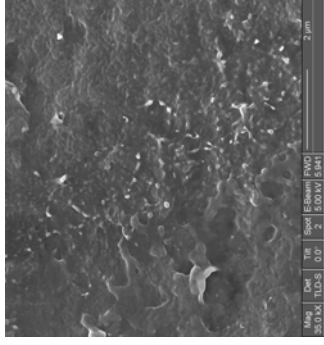
Epoxy resin and CFRP mechanical properties enhancement with UNCD

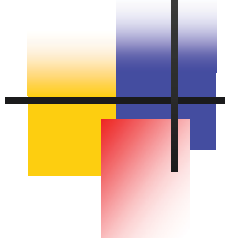
(Joint research with SINTA Ltd., Ukraine)

Ultra-NanoCrystalline Diamonds, UNCD

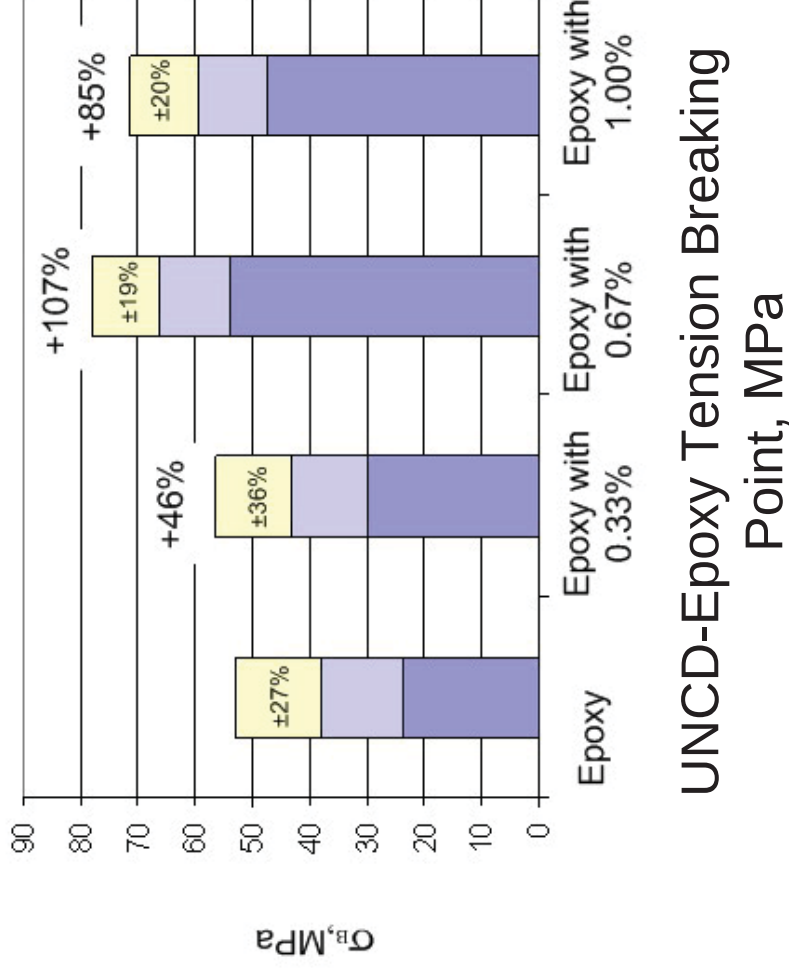
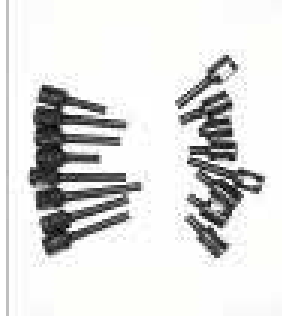


Crystal Size	4 – 8 nm
Aggregate size	20 – 50 nm
Specific Surface	300 m ² /g
Density	3.1 – 3.2 g/cm ³
Bulk Weight	0.4 – 0.6 g/cm ³
Lattice Constant	0.3573 nm





UNCD-Epoxy test:

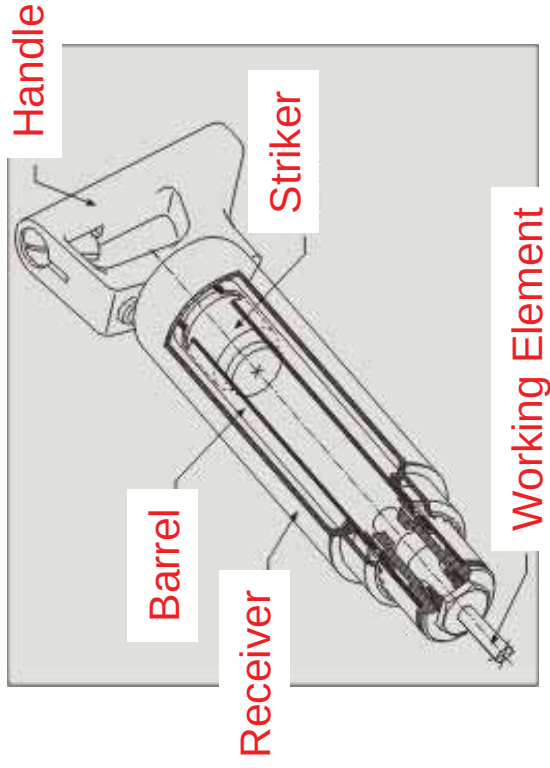


(107% increasing)



Composite Laminates Single-Impact Riveting Technology

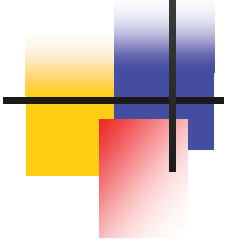
(STCU P245 project with Boeing)



1. Compressed air energy accumulated in the receiver
2. Energy released
3. Striker is accelerated in the barrel
4. Striker hits working element
5. Working element = rivet die



MPI-90M Riveting Hammer



Current FP7 Aeronautic Call

project ideas

- **WASIS-M** — Composite Fuselage Section Wafer-design Approach for Safety Increasing in Worst-case Situations and Minimizing of Joints
- **ALSYS** - Composite Aircraft Active Lightning-strike Protection System
- **COALIS** - Composite Aircraft Lightning-Strike Protection with Advanced Materials
- **FREE-AIR** - Family/business Autogyro with “Jumping” Take-off and Vertical Landing as a Future Personal Air Transport System Foundation



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