# *Questionnaire*

## Summary of the main activities of a scientific Organisation of the Slovak Academy of Sciences

*Period: January 1, 2003 - December 31, 2006*

## *I. Formal information on the assessed Organisation:*

1. **Legal name and address:**
   Institute of Materials & Machine Mechanics, Slovak Academy of Sciences,
   Račianska 75, 831 02 BRATISLAVA 3

2. **Executive body of the Organisation and its composition:**

| Directoriat | name | age | years in the position |
|---|---|---|---|
| **directors** | Ing.Vladimír Giba, PhD.<br>Dr. Ing. František Simančík | 62<br>44 | 1996-2004<br>2004 - |
| **deputy director** | Dr.Ing.František Simančík<br>Ing.Vladimír Giba, PhD<br>Ing. Karol Iždinský, PhD. | 44<br>62<br>47 | 1994-2004<br>2005<br>2006 - |
| **scientific secretary** | Dr. Ing. Jaroslav Jerz | 41 | 2002 - |

3. **Head of the Scientific Board**
   Ing.Karol Iždinský, PhD. (1999-2006)
   Ing. Juraj Lapin, PhD. (2006-)

4. **Basic information about the research personnel**
   i. *Number of employees with a university degree (PhD students excluded) engaged in research and development and their full time equivalent work capacity (FTE) in 2003, 2004, 2005, 2006 and average number during the assessment period*

   ii. *Organisation units/departments and their FTE employees with the university degree engaged in research and development*

| Research staff | 2003 | | 2004 | | 2005 | | 2006 | | average | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | FTE | No. | FTE | No. | FTE | No. | FTE | No. | FTE |
| **organisation in whole** | 37 | 34,4 | 36 | 35,5 | 41 | 37,7 | 45 | 39,7 | 39,75 | 36,825 |
| **Division 1: New materials & technologies** | 6 | 6 | 6 | 6 | 10 | 9,4 | 12 | 10,6 | 8,5 | 8 |
| **Division 2: Microstructure of surfaces & interfaces** | 10 | 10 | 10 | 9,5 | 11 | 10,5 | 12 | 11,5 | 10,75 | 10,375 |
| **Division 3: Properties of materials & structures** | 16 | 13,4 | 15 | 15 | 13 | 10,8 | 14 | 10,6 | 14,5 | 12,45 |
| **Public relations** | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Branch Martin** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

## 5. Basic information on the funding

*i. Total salary budget[1] of the Organisation allocated from the institutional resources of the Slovak Academy of Sciences (SAS) in 2003, 2004, 2005, 2006, and average amount for the assessment period*

| Salary budget | 2003 | 2004 | 2005 | 2006 | average |
|---|---|---|---|---|---|
| **total salary budget (millions of SKK)** | 16,508 | 16,715 | 16,367 | 18,159 | 16,937 |

## 6. URL of the Organisation's web site

http://www.umms.sav.sk

[1] Sum of the brutto salaries without the fund contributions.

## *II. General information on the research and development activity of the Organisation:*

### 1. Mission Statement of the Organisation as presented in its Foundation Charter

The main objective of Institute of Materials and Machine Mechanics SAS (IMSAS) is to perform basic and applied research in the field of materials engineering and machine mechanics:

Materials research is oriented to the development of advanced metallic materials, especially composites and metallic foams, by modern technologies, such as pressure infiltration, vacuum diffusion bonding, CVD, PVD, plasma spraying, unidirectional solidification of eutectics, powder metallurgy, etc. The development of materials is supported by research facilities for evaluation of the structure and determination of almost all basic material's properties.

Machine mechanics deals with the research on deformation of elasto-plastic continuum, incl. composites, develops theoretical knowledge concerning fatigue endurance of machine and structures under stochastic loading, noise- and vibration control and acoustoelasticity.

IMSAS provides expertise and other services concerning with main objective of the organisation

IMSAS performs scientific education within generally valid legal regulations.

IMSAS publishes the research and scientific results in scientific journals or other non-periodical publications. IMSAS issues scientific journals according to regulations of Presidium of SAS.

### 2. Summary of R&D activity pursued by the Organisation during the assessed period, from both national and international aspects and its incorporation in ERA

The selection of topics for systematic research was strongly affected by institute's research tradition, competence of leading researchers and availability of technological devices and equipment for characterisation and testing. Because of almost zero funding for investments in the past, the upgrade of equipment was possible only from limited institute's own resources generated by external incomes. This fact influenced the main orientation of research activities towards technological, application derived development with lower portion of typical fundamental research, which needs advanced (and expensive) high-tech characterisation equipment. The absence of such equipment was mostly balanced with the extraordinary technological ability of Institutes to prepare unique high-tech materials, which enabled to keep its competitiveness at European level. The lacking equipment necessary for reliable investigation was involved into the research through large international cooperation with better equipped institutions that on the other hand appreciated the possibility to test unique advanced materials.

Therefore all research activities were performed rather on international than national level using grants and projects awarded by various agencies and also by many industrial partners.

In accordance with the Foundation Charter and abovementioned reasons main institute's R&D activities in assessed period were devoted to the development of:

- advanced metallic materials in particular metal matrix composites, metallic foams, intermetallics, nanostructured aluminium alloys and coatings
- unique technologies and equipment for manufacturing and characterisation of investigated materials
- methods for characterisation of structural properties in complex systems with an impetus on characterisation of interfaces
- models for reliable estimation of fatigue endurance limits under stochastic loading

- methods and models for evaluation of creep properties of materials
- methods for simulation and modelling of vibration response as well as for prediction of the vibro-acoustic behavior of complex structures in mid- and high-frequency range.

The most important R&D results obtained in assessed period are described in following paragraphs:

***Metal matrix composites (MMC)***

Various types of metal matrix composites reinforced with continuous monofilaments, wires, short fibres, particles or ceramic or graphite skeletons *e.g.* Al-B, Cu-W, Al-C, Mg-C, Cu-C, Al-SiC, Al-Fe, Sb-C have created a main subject of Institute's interest since early 60-ies. The research in this field driven by the constantly increasing interest of both academic and industrial partners proceeded also in the assessed period of time.
However, in distinction to previous years, where the main attention was paid to the improvement of mechanical properties, recent activities are mostly devoted to explore unique functionality of composites especially in components for thermal management, where the improvement of thermal conductivity has to be combined with possibility to control coefficient of thermal expansion (CTE) and with sufficient structural stability under thermocyclic loading. This topic has been investigated mostly within the frame of integrated project of the 6th FP EU ExtreMat, where IMSAS plays an important role in coordination of one of 4 subprojects, which is devoted to development of novel heat sink materials with high thermal stability and high thermal conductivity. Beside coordination the main attention of Institute's activities is focused on the research and development of copper matrix composite materials reinforced with W wires and high modulus C fibres. These are aimed for divertors of the new generation of fusion reactors (high thermal stability) and for different applications in power-electronics, opto-electronics, microelectronic packages, novel SiC chips, etc. respectively.

Further activities in MMC field included development and study of properties for MgLi composites reinforced with short alumina fibres, interactions of components and interfaces in magnesium based composites, development of the manufacturing of ceramic/lead composites by the melt infiltration process for the battery applications, optimization of properties and joining of metal matrix composites, impregnation of carbon-graphite preforms with copper and copper alloys for electric contact materials.

Some of the most important contributions to the development of metal matrix composite science include:

- determination of precipitation phenomena and work hardening of short-fiber reinforced MgLiAl matrix composites
- contribution to the explanation of deformation mechanisms of channel-die compressed Mg-Li alloys via acoustic emission measurements
- explanation of the effect of Li content on the thermal strain in MgLi-Saffil fibre composites
- the analysis of the reaction pathway of silicon in alumina/magnesium based MMCs
- characterization of the effect of interfaces on fibre fracture in Mg and MgLi matrix composites
- development and optimization of the manufacturing process for ceramic/lead composites by the melt infiltration for the battery applications, including alloy optimisation
- optimization of gas pressure infiltration technique for the preparation of Cu-C and Cu-W composites, again including optimisation of alloy to provide sufficient wetting and optimum interfacial properties
- development and optimization of the technology for infiltration of graphite with molten copper for serial production of sliding contacts

The research activities related to metal matrix composites were performed mostly within a frame of 1 integrated 6FP EU project, two large industrially funded projects and several small projects supported by the Scientific Grant Agency of SAS (SGA SAS). The total additional funding comprised 25.638.468,- Sk including 9.390.125,- Sk from public grant sources and 16.247.943,- Sk from industry. The achieved results were published (providing it was possible within signed non disclosure agreements) in 4 monograph chapters, 31 journal articles and 24 conference papers among them 2 invited lectures. The effort resulted in the new contract on technology transfer to national industry partner, who is aiming to use gas pressure infiltration of graphite components with copper alloy for manufacturing of sliding contacts for trolley vehicles. Moreover three other bilateral contracts with foreign industrial partners aiming for development of high conductivity heat sink materials are currently under negotiations. Institute has also been invited to join consortium going to submit proposal for large research project within new call in 7FP EU.

***Intermetallics***

Based on the original expertise in design, directional solidification and characterization of nickel based alloys for high temperature structural applications, the research has been redirected to multiphase intermetallics since 1994. Design of new advanced multiphase nickel based multiphase intermetallic alloys, development of unique processing techniques for iron based intermetallics and titanium based intermetallic matrix composites including extended characterization of microstructure and properties of these systems were performed within several national (SGA SAS) and international (COST) projects and extensive international cooperation. The high level of IMSAS competence in this field was recognised by the award of another integrated project of the 6th FP EU IMPRESS where Institute's role is to coordinate the research on fundamentals of solidification of TiAl based alloys, whereas IMSAS takes part on microgravity solidification experiments, alloy selection and characterization of mechanical and microstructural properties of new developed systems. The contribution of IMMM to the particular knowledge in the field of intermetallics includes:

- development of a new group of multiphase intermetallic alloys based on ternary Ni-Al-Cr system with NiAl primary solidification phase and characterization of their microstructure and properties after directional solidification and heat treatments
- elucidation of the effect of coexisting phases on tensile properties, high temperature creep behaviour, room temperature ductility, oxidation behaviour and tailoring microstructure and mechanical properties of directionally solidified (DS) multiphase Ni-Al-Cr based alloys for specific structural applications
- extension of fundamental knowledge on columnar dendritic growth of new DS Ni-Al-Cr based multiphase intermetallic alloys with the NiAl primary solidification phase and characterization of the effect of growth parameters on the stability of solid-liquid interface in relation to formation of single crystalline, cellular a dendritic structures
- characterization of creep properties, determination of kinetics of creep deformation, identification of creep mechanisms and creep fracture in newly developed DS Ni-Al-Cr based multiphase intermetallic alloys with the NiAl primary solidification phase
- development and characterization of new type of composite material with TiAl based intermetallic matrix reinforced with homogenously distributed ceramic particles formed in-situ during directional solidification
- development and experimental verification of an analytical model for the prediction of the yield stress of TiAl based matrix in-situ composites, which includes the contribution of TiAl matrix, lamellar structure and volume fraction of reinforcing ceramic particles

- development and experimental verification of an analytical model for the prediction of the yield stress of DS eutectic composites reinforced with ductile fibres
- determination of kinetics of softening during long-term ageing of TiAl based alloys and prediction of effect of microstructural instabilities on long-term performance of turbine blades
- identification of creep mechanisms, determination of kinetics of creep deformation, microstructure stability and creep fracture characterization in TiAl based alloys for turbine blade applications
- development of an original technique based on reactive infiltration of iron fibre preforms with liquid aluminium for processing of iron aluminides and characterization of microstructure and mechanical properties of single shape castings prepared by this technique

The research activities related to intermetallics have gained additional 9.060.275,- Sk from public grant sources. The achieved results were published in 1 monograph chapter, 19 journal articles and 10 conference papers. Among them 2 invited lectures can be outlined. IMSAS was invited into two consortia going to submit proposal for large research project within new call in 7FP EU.

***Metallic foams***

The research on metallic foams was initiated at IMSAS in 1994 and since then represents one of the highlights of Institute's research activities. In the reported period the main research activities in this field were accomplished within one national SGA SAS project and two long-term bilateral industry projects. Respecting the strategy of industrial partners to keep the main results confidential, no application for EU funding was attempted for this research.
Some of the most important contributions to the particular knowledge in the field of metallic foams include:

- description of foam and foam sandwich behaviour under cyclic loading
- description of the effect of thermal treatment of Al foam
- comprehensive study of sound absorption ability of metal foams
- development of novel aluminium foam composites reinforced with expanded (stretched) steel mesh by in situ foaming (patent pending)
- development of a method for reinforcement of solid metal foam (patent pending)
- development of a method and equipment for manufacturing of foamed parts with precise dimensions (patent pending)
- design and preparation of foamed panels acting as heat exchangers (patent pending)
- design and construction of computer controlled expandometer for determining the foaming properties of various precursors

The research activities related to metallic foams have additionally gained 20.057.301,- Sk including 250.000,- Sk from public grant sources and 19.807.301,- Sk from industry. The achieved results were published in 1 monograph chapter, 5 journal articles and 31 conference papers. Among them 2 invited plenary lectures at recognised international Metfoam congresses can be outlined. The research effort resulted in 3 new patent applications, two EP were already granted. Beside them 6 patents were granted in reported period based on older applications. Several foam aluminium prototypes were developed and tested in real loading conditions (more information can be found in chapter 6).
In 2006 serial production of aluminium foam crash absorber developed at IMSAS for AudiQ7 car has started. With an annual production of 200.000 pcs is this part worldwide the first large volume series aluminium foam application in automotive industry. IMSAS competence was recognized also by main "European research competitor in this field

(IFAM FhG Bremen)", who ordered manufacturing and delivery of a special device for foam expansion measurement from IMSAS.
The unique results obtained in the research on aluminium foams were awarded by the prestigious 2006 annual price of Slovak Academy of Sciences.

***Nanostructured Al alloys with high temperature stability***

The original experience, resulting from the compaction and consolidation of short fibre reinforced metal matrix composites, has been applied for the development of nanostructured Al alloys with high temperature stability. The research was oriented towards three main topics including compaction of powders of hypereutectic AlSi alloys, compaction and study of properties of profiles made from ultrafine (< 1 μm) Al powder and compaction of AlFeV nanoscale alloys prepared by rapid solidification technique. Based on the achieved results IMSAS has been admitted to the Slovak Academy of Sciences Centre of excellence for the research on nanostructured materials NANOSMART. Moreover, IMSAS is the representative and coordination body of Slovak republic in the 6$^{th}$ EU FP "Nanoscience in the European Research Area"

Some of the most important contributions to the particular knowledge in the field of nanostructured Al alloys include:
- development of new dispersion strengthened material based on hot extrusion of ultrafine Al powders exhibiting high strength, ductility and structural stability up to the temperature of 400 ℃. This material currently undergoes systematic testing in engines of sporting car in a frame of bilateral contract with foreign industrial partner.
- development of unique composite materials based on ductile Al matrix created by compaction of ultrafine Al powders, which is reinforced with high-strength ribbons prepared by rapid solidification of AlFeV alloys
- development of unique technique based on equal channel angular pressing for the compaction of AlFeV nanostructured melt spun ribbons, yielding profiles with outstanding strength and structural stability. The compaction method is very suitable for industrially relevant conditions, where it was already successfully tested.
- development of compaction route for hypereutectic AlSi alloys that has resulted in the serial production (300.000 pc/year) of stators of camshaft phaser for automotive engine (national industry partner)

The research activities related to nanostructured Al alloys have gained additional 12.340.057,- Sk including 8.537.515,- Sk from public grant sources and 3.802.542,- Sk from industry. The obtained results were published in 3 journal articles and 12 conference papers. Among them 1 invited lecture can be outlined. Two PhD theses based on these results were defended in the assessed period of time.

***Coatings***

IMSAS competence in the field of coatings currently covers three different areas including copper and nickel coating of carbon fibres, air plasma spraying and physical vapour deposition by magnetron sputtering. These techniques are used to surface modifications, deposition of protective and resistant layers, worn surface renovations and deposition of superhard coatings. The research activities are supported by national grants and cooperation with national and foreign industrial partners.

Some of the most important contributions related to coatings include:
- development of galvanic coating of Ni on the surface of C fibres in order to get plastic matrix composite material with extraordinary electro-magnetic shielding properties (patent pending)
- deposition of NiCrAlY coatings by plasma spraying technology and characterization of phase transformations set up by subsequent thermal treatment
- determination of the microstructure of NiAl powder used for plasma spraying

- plasma spraying of protective $ZrO_2$, $TiO_2$ coatings
- plasma spraying of functionally graded Cu-W coatings for potential fusion applications
- consolidation of plasma sprayed coatings by subsequent hot isostatic pressing
- deposition of superhard $TiB_2$ coatings on steel, silicon and WC-Co surfaces by balanced and unbalanced DC magnetron sputtering
- determination of the influence of post annealing on the structure, hardness and residual stresses of $TiB_2$ superhard coating

The research activities related to coatings were supported with 2.759.262,- Sk including 1.164.000,- Sk from public grant sources and 1.595.262,- Sk from industry. The achieved results were published in 4 journal articles and 8 conference papers. One PhD thesis was submitted within the assessed period of time.

***Soldering***

Soldering research at IMSAS reflects two general requirements. Both are nationally as well as internationally relevant. They are related to the development of lead free solder materials and to joining of composites via soldering technology. The Institute´s research activities were covered by national SGA SAS grant and COST project (531.1, 51-98-9345-00/2002).
Some of the most important contributions related to soldering include:

- design and manufacturing of completely new equipment for the measurement of wetting angle using the sessile drop technique
- determination of the wetting of copper substrate with Sn-3.5Ag, Sn-3.5Ag-6In and Sn-3.5Ag-9In
- characterisation of the microstructure of the soldered joints and its behaviour under thermal cycling in the temperature range up to 150 ℃

The research activities related to coatings were additionally funded by 175.000,- Sk from public grant sources. The obtained results were published in 4 journal articles and 5 conference papers.

***Vibration analysis and active suspension systems***

This particular research is performed in order to get the fundamental knowledge aimed for the evaluation and improvement of suspension seat vibration isolation performance. Advanced non-linear models of driver's seats suspension systems were developed providing realistic exciting signal for various vehicle models.
This problem was investigated in a frame of 5th FP EU project VIBSEAT where IMSAS had 9 partners from 5 EU countries. The main goal of the project was to improve methods of vehicle drivers protection against whole-body vibration, that are urgently required to assist vehicle manufacturers and operators in complying with European Directive 2002/44/EC. This directive limits the maximum daily permitted vibration exposure and will come into force of law for all EU member states by July 2005.

Some of the most important contributions of IMSAS related to vibration analysis and active suspension systems include:

- determination of the influence of passenger's mass and posture on response to random vibration
- theoretical investigation of a linear planar model of a passenger car with seated people
- dry-friction modelling in simple, kinematically excited vibration isolation systems
- vibration mitigation by intelligent control of seat suspension damper
- determination of effects of obstacles on the indicators of road unevenness

- modelling of oscillatory systems with viscous and dry-friction damping under real random kinematical excitation
- identification and optimisation of a vertical seat suspension system for a railway vehicle
- development of x-direction apparent mass model of human body sitting in vehicle seat

The research activities related to vibration analysis and active suspension systems were funded with 2.442.939,- Sk from national and international public grant sources. The achieved results were published in 21 journal articles and 19 conference papers. One PhD thesis was submitted within the assessed period of time.

***Fatigue life and reliability assessment***

The research in this field is focused on the analysis and proposal of methods for the estimation of fatigue life and reliability assessment of mechanical systems under variable parameters of random loading. The aim is to provide the system for continuous monitoring of fatigue reliability, being able to record and evaluate the service loading. This real-time computing is crucial for the well-timed assessment of the actual extent of fatigue damage. This research activity was covered by national SGA SAS grant and cooperation with foreign industrial partners.

Some of the most important contributions of IMSAS related to estimation of fatigue life and reliability assessment include:

- assessment of fatigue life and reliability under variable parameters of random loading
- modelling of a material degradation and damage mechanics in machine structures under service loading
- development of cumulative damage model in structure materials
- fatigue life estimation of steel structures under non-stationary random loading using quadratic damage rule
- quadratic damage rule in random loading case
- development of system for continuous assessment of fatigue reliability of mechanical structures
- fatigue assessment based on statistical analysis of theoretical parameters

The research activities related to estimation of fatigue life and reliability assessment were funded with 626.000,- Sk including 374.000,- Sk from national grant sources and 252.000,- Sk from industry. The achieved results were published in 5 journal articles and 6 conference papers. One PhD thesis was submitted within the assessed period of time.

***Power flow paths and energy transfer in mechanical systems***

The aim of this research is the determination of power flow paths and their quantitative assessment. Different models are proposed and analysed particularly for composite structures. This research activity was performed by researchers from Institute’s branch Martin and was mainly supported by national SGA SAS grant.

Some of the most important contributions related to determination of power flow paths and energy transfer in mechanical systems included:

- determination of energy flow of axisymmetric elastic waves in a three-layered, transtropic-isotropic-transtropic, composite cylinder
- determination of dispersion and energy flow of elastic waves in cylindrical laminated composites
- characteristics of some properties of determinants and their use in paths in valuated graphs
- determination of dispersion of torsion waves in a thick-walled transversely isotropic circular cylinder of infinite length

- assessment of the influence of internal damping and fast excitation on a linear string vibration
- determination of energy flow of torsion waves in a transversely isotropic cylinder
- characteristics of paths in valuated graphs and their use in acoustics
- determination of dispersion and energy flow of rotationally symmetric elastic waves in a long annular multi-layer cross-laminated composite cylinder.

The research activities related to determination of power flow paths and energy transfer in mechanical systems have additionally gained 519.000,- Sk from national grant sources. The achieved results were published in 7 journal articles and 14 conference papers. Two PhD theses were defended within the assessed period of time.

***Additional R&D activities***

Besides the mainstream research also additional R&D activities were performed in assessed period. These included small scientifically oriented projects funded mostly by SGA SAS, education activities and expertise for industrial partners (more than 50 particular projects). More details concerning these activities are given in next chapters or at the internet web site of the Institute.

## 3. Concept of R&D activity of the Organisation for the next four years

*i. Present state of knowledge and status of ongoing research related to the subject of the Concept, from both international and national perspective*

As it was presented in previous chapters the main mission of IMSAS is to perform basic and applied research in the field of materials engineering and machine mechanics. It is obvious, that for further development of the society new high performance materials are inevitable.
The research oriented towards applications of new materials and technologies will therefore still play very important role. Such research can substantially increase added value of components and has thus a good chance to be financially supported. This is true for both international and also national perspective. In case of new materials and technologies it is not important to differentiate between them, because their targets are the same. To keep a sustainable growth, Institute must be definitely competitive at international level. This will allow necessary financing from large EU projects and /or from stronger (better developed) industry, which is inevitable for Institute's existence (currently institute has to gain about 50% of finances from external sources, whereas industrial projects cover more than 25% of institute's budget). The growing interest of both international and national industry in the Institute's research results (documented by increasing bilateral cooperation) gives an indication that the research strategy is correct and that there is no strong need to change it significantly. Therefore the most successful research topics will be followed also in future four years.

Material research will continue in the development of advanced metallic materials in particular metal matrix composites (MMC), intermetallics, foams, nanostructured alloys and coatings:

**Research on MMC** will be mainly devoted to optimisation of materials for thermal management which includes tailoring of interfaces with an aim to improve thermal conductivity, control CTE and stabilise the structure under thermocyclic loading. The main target will be to increase structural stability of materials for high temperature performance and to substantially increase their thermal conductivity. Fundamental research will be oriented towards understanding of processes and reactions at interfaces between composite constituents. The effort will be made to establish a research group dealing with calculation and modelling of such complex structures.

**Resarch on intermetallics** will be oriented towards development of advanced multiphase intermetallic alloys and single crystalline nickel based superalloys as well as original cast technologies for their processing. Main attention will be paid to understanding of fundamental phenomena controlling microstructure evolution and degradation during solidification, heat treatments and long term high temperature exposure. The effort will be made to develop analytical models describing relationships between microstructure parameters and mechanical properties.

**Research on metallic foams** will comprise investigation of relationship between porous structure and foam properties including study of thermal treatment effects. As the stochastic structure of complex shaped foam part does not allow reliable calculation of the properties, manufacturing of prototypes and their experimental testing will be still necessary. Therefore novel method for rapid prototyping of net shape foam parts will be developed and optimised for this purpose. The attention will be paid also to the optimum use of reinforcements in foam matrix with an aim to apply such composite as lightweight selfstanding structural part and replace thus complex welded or cast structures. Application of tube-reinforced foam in heat exchangers for low energy houses (cooling and heating ceiling and wall panels, incl. solar applications) will be further optimised.

Finally development of novel method for manufacturing low-cost foams directly from aluminium melt will be attempted.

**Research on nanostructured aluminium alloys** will be oriented towards improvement of high temperature structural stability above 300 C. Here the profound understanding of structure development from rapidly quenched state is crucial precondition. The stability of nanostructure will be controlled by (in situ) involvement of hardly soluble quasicrystalline phases, intermetallics or oxide dispersoids. The properties will be optimised from the fatigue and creep resistance point of view. The development of rapidly solidified alloys will be accompanied by the development of suitable – industrially relevant - compaction techniques. From this point of view very promising ECAP compaction will be further optimised.

**Research on coatings** will be mainly oriented to the development of functionally graded plasma sprayed Cu-W coatings for use as protection or semilayer coatings in high temperature reactors, and ultrahard nanostructured PVD coatings with improved wear resistance. Attention will be paid to the optimisation of interface between substrate material and coating in order to improve adhesion and stability under cyclic loading.

The attention must be also paid to the **development of suitable technologies**, which allows cost efficient manufacturing of net shape components. Such technologies are inevitable for industrial application of developed advanced materials. In case of MMC the main effort will be given to optimisation of gas pressure infiltration, including optimisation of alloy to enable wetting, but prevent excessive reaction with infiltrated component. Suitable method for manufacturing of performs especially from continuous fibres must be developed as well. Powder metallurgical approaches will be optimised for preparation of nanostructured materials from rapidly solidified powders and ribbons. The compaction techniques will be developed with respect to the feasibility for potential industrial applications.

In the field of **machine mechanics** the research will cover:

- identification, simulation and modelling of interactions of structural part with surrounding environment (loading, vibrations, etc.) with main attention paid to interactions between road and vehicle. The research effort will concentrate towards complex estimation of influence of various non-standard road profiles on the road quality indices and assessment and their utilization for dynamic response simulation and performance prediction of various vehicles.
- estimation and/or calculation of operational fatigue endurance of structural part under stochastic loading, with an aim to develop credible methodology of evaluation of fatigue life, reliability and safety of structure operation for the complicated load conditions and new advanced materials
- vibration control of structural part with an aim to improve human body protection against whole body vibration, including simulation and modelling, whereas an technically and economically viable vibration control mean for vibration mitigation in non-vertical directions will be optimised.

*ii. Organisation's role or significance in the overall research effort within the field of the Concept on both the national and international scales*

As it is reported in chapter III.3 IMSAS is well positioned in European research scene with respect to abovementioned topics. The competence of Institute can be documented e.g. with invitation to consortia which are going to submit proposals for 7FP EU (already four invitations for large projects – 1 for MMC, 2 for intermetallics and MMC, 1 for coatings), and many suggestions for bilateral industrial cooperation (2 for foams, 5 for composites, 2 for nanostructured materials, etc.).

*iii. Objectives of the Concept*

The motivation for proposed research on **advanced materials** is derived from societal needs and requirements. The main fields of institute's interest are:

- **lightweight structural materials**
  Weight reduction of structural components is long term motivation of all designers. Lower weight of especially moving parts can significantly increase their performance with simultaneous decrease of energy consumption and environmental loading. In lightweight design the highest specific stiffness and strength of the components can bring the best benefits. Here two approaches are possible; increase specific properties of particular structural materials (e.g. making composites, improving (nano)microstructure) or optimise a structural design of components (making lightweight structure e.g. foams, sandwiches etc.)
- **materials for thermal management**
  Further development in many technical fields is strongly crimped with raising problem of thermal management of high-tech components. At present overheating causes more than 50 % failures of electronic devices and the high temperature becomes a limiting factor also in construction of heat exchangers, fusion reactors, thrusters chambers, brake systems, aircraft engine parts etc.
  The introduction of new high performance electronic components or high temperature plasma reactors constantly generating more heat than their current predecessors will in short term require novel thermal management approaches able to dissipate almost 20 MW per square m. This will be possible only with heat spreaders or heat sinks made of materials possessing extremely high thermal conductivity, ability to withstand large temperature changes without disintegration and deterioration of properties and capability to reduce complex thermo-mechanical stresses after bonding to supporting or protecting structures by tailoring of CTE. The use of metal matrix composites is probably inevitable also in this case.
- **structural materials for high temperature performance**
  Increase of the efficiency and decrease of fuel consumption and green house gas emissions of engines, gas turbines for power engineering and aircraft industry require continuous increase of operating temperatures of materials used for their production. For such components specific high-temperature strength, room-temperature fracture toughness and reliability in operation are crucial issues. Nowadays, there is no alternative material, which might fully compete with single crystalline nickel based superalloys currently used for applications in the high pressure first stage of gas turbines. In the case of low pressure stage of gas turbine as well as for some high-temperature applications in automotive industry cast titanium and iron based multiphase intermetallic alloys were identified to be promising systems to replace nickel and iron based superalloys currently in use.
- **Fatigue of material** still belongs to the most frequent cause of breakdown of engineering structures, despite of been dealt with worldwide for more than 150 years. This is due to the complexity of the fatigue process and in a great number of influencing factors. Therefore development of a new effective procedures and methods, enabling to evaluate reliability of a structure in view of fatigue-fracture occurrence, is still a topical problem and subject of intense research. An optimum structure design calls for use of advanced materials (composites, ceramics, polymers), which perform better than traditional ones; however the interaction between material performance and dynamical loading of those materials is still not completely understood. This is the motivation for furthering research into this problem.
- The Directive EC/2002/44 commands the minimal requirements on health and work safety in respect to prolonged **influence of mechanical vibration** and mechanical shocks on industrial workers. For assessment of vibration exposure limit values are

stated. If exceeded mandatory measures on the employer's part are necessary to decrease the influence of vibration below the allowable limit. Improvements of driver's seats vibration control properties, using passive, semi-active and active vibration control means are one of the technical means for reaching this goals, nowadays especially in the non-vertical directions.

*iv. Proposed strategies and methods to be applied, and time schedule*

Continuation in traditional research themes will be beneficial if experience and competence of leading researchers and availability of technological devices and equipment for characterisation and testing are concerned. In current case of subcritical funding of the research from public resources is such philosophy inevitable.

The most important and crucial task in the proposed research is to find sufficient financial resources for this plan. From this point of view the situation is rather optimistic; the necessary financial resources are available at least for next two years. Several proposals will be elaborated for 7 FP EU, three new industrial contracts are under negotiation. IMSAS submits yearly about 3-4 proposals also to Agency for Research and development (APVV) and these initiatives will continue also in next years providing the selection process will be fair and equitable (unfortunately some doubts about it exists).

IMSAS possesses all necessary equipment for proposed research, although some of the devices especially for structural characterisation of materials are of old generation. Substantial improvement of research infrastructure can be realistically expected in coming years, thanks the availability of European structural funds. Since the principles which will be applied for distribution of these funds are still not clear, preparation of feasible research strategy is not easy. Nevertheless, such unique opportunity must be considered as one of the most important challenges for future years. If European funds provide resources necessary for furnishing of SAS institutes with high-tech equipment the portion of high-quality fundamental research can be substantially increased. Paradoxically, in this effort successful application oriented research may be quite helpful.

In case of sufficient investment costs, better characterisation equipment will be purchased, in particular high resolution TEM, nanoindenter, and various analytical devices. To enhance the flexibility in preparation of alloys for all concerned materials vacuum melting technologies combined with melt spinning device will be installed.

Following approaches will be implemented wherever possible to guarantee high-quality and efficiency of the research level:

- Advanced process engineering
- Multiscale modelling of structure-behaviour relations (on nano-micro-macro scale)
- Understanding of phase transformations
- Interface science and microstructure design
- Interdisciplinary character comprising metallurgy, physics, chemistry, mathematics and informatics

## *III. Partial indicators of the main activities:*

### 1. Research output

***i. List of the selected publications documenting the most important results of basic research. Total number of publications in the whole assessed period should not exceed the average number of the research employees***

[1] LAPIN, J. Creep behaviour of a cast intermetallic Ti-45.2Al-2W-0.6Si-0.7B alloy. In *Scripta Materialia.* Vol. 50, no. 2(2004), p. 261–265. CCC (2,112 – IF2004)

[2] LAPIN, J. Embrittlement of directionally solidified Zr-doped multiphase intermetallic Ni-Al-Cr-Ta-Mo aaloy after heat treatment. In *Scripta Materialia.* Vol. 51, no. 7 (2004), p. 733-738. CCC (2,112 – IF2004)

[3] LAPIN, J. – VAŇO, A. Coarsening kinetics of α- and γ'-precipitates in a multiphase intermetallic Ni-Al-Cr-Ti type alloy with addition of Mo and Zr. In *Scripta Materialia.* Vol. 50, no. 5(2004), p. 571-575. CCC (2,112 – IF2004)

[4] MAZÚCH, T. Powerful FE approaches for Pochhammer's dispersion modelling. In *International Journal for Numerical Methods in Engineering.* Vol. 57, no. 4(2003), p. 555–576. CCC (1,691 – IF2003)

[5] LAPIN, J. – KLIMOVÁ, A. – PELACHOVÁ, T. Softening of a cast intermetallic Ti-46Al-2W-0,5Si alloy during annealing at 700-800℃. In *Scripta Materialia.* Vol. 49, no. 7(2003), p. 681-686. CCC (1,633 – IF2003)

[6] KÚDELA, S. – OSWALD, S. – KÚDELA, S., Jr. – BAUNACK, S. – WETZIG, K. The ion exchange promoted interfacial strength in magnesium based composites. In *Journal of Alloys and Compounds.* Vol. 378, nos. 1-2 (2004), p.127-131. CCC (1,562 – IF2004)

[7] LAPIN, J. Creep behaviour of a cast TiAl-based alloy for industrial applications. In *Intermetallics.* Vol. 14, no. 2 (2006), p. 115-122. CCC (IF2005 – 1,557)

[8] LAPIN, J. Effect of directional solidification and heat treatments on the microstructure and mechanical properties of multiphase intermetallic Zr-doped Ni-Al-Cr-Ta-Mo alloy. In *Intermetallics.* Vol. 14, no. 12 (2006), p. 1417-1427. CCC (IF2005 – 1,557)

[9] LAPIN, J. – MAREČEK, J. Effect of growth rate on microstructure and mechanical properties of directionally solidified multiphase intermetallic Ni-Al-Cr-Ta-Mo-Zr alloy. In *Intermetallics.* Vol. 14, nos. 10-11 (2006), p. 1339-1344. CCC (IF2005 – 1,557)

[10] LAPIN, J. – PELACHOVÁ, T. Microstructural stability of a cast Ti-45.2Al-2W-0.6Si-0.7B alloy at temperatures 973-1073 K. In *Intermetallics.* Vol. 14, nos. 10-11 (2006), p. 1175-1180. CCC (IF2005 – 1,557)

[11] LAPIN, J. – NAZMY, M. Microstructure and creep properties of a cast intermetallic Ti-46Al-2W-0.5Si alloy for gas turbine applications. In *Materials Science and Engineering A.* Vol. 380, nos. 1-2 (2004), p. 298-307. CCC (1,445 – IF2004)

[12] LAPIN, J. – ONDRÚŠ, Ľ. – BAJANA, O. Effect of $Al_2O_3$ particles on mechanical properties of directionally solidified intermetallic Ti-46Al-2W-0.5Si alloy. In *Materials Science and Engineering A.* Vol. 306, nos. 1-2(2003), p. 85–95. CCC (1,365 – IF2003)

[13] LAPIN, J. Microstructure and mechanical properties of iron aluminides processed by reactive squeeze infiltration. In *Materials Letters.* Vol. 58, no. 24 (2004), p. 3007-3011. CCC (1,186 – IF2004)

[14] IŽDINSKÝ, K. – IVAN, J. – ZEMÁNKOVÁ, M. – CSUBA, A. – MINÁR, P. – IŽDINSKÁ, Z. Microstructure of air plasma sprayed NiAl coating isothermally exposed

at 850℃ for 6 minutes. In *Kovove materialy-Metallic Materials.* Vol. 42, no. 5 (2004), p. 316-328. CCC (1,056 – IF2004)

[15] KOVÁČIK, J. – EMMER, Š. – BIELEK, J. Thermal properties of Cu-graphite composites. In *Kovove materialy-Metallic Materials.* Vol. 42, no. 6 (2004), p. 365-374. CCC (1,056 – IF2004)

[16] KOVÁČIK, J. – SIMANČÍK, F. Comparison of zinc and aluminium foam behaviour. In *Kovove materialy-Metallic Materials.* Vol. 42, no. 2 (2004), p. 79-90. CCC (1,056 – IF2004)

[17] ŠEBO, P. – ŠTEFÁNIK, P. – KAVECKÝ, Š. Joining of copper-carbon fibre composite with gold coated alumina by low temperature In-Pb and Soldamol 170 solders. In *Kovove materialy-Metallic Materials.* Vol. 42, no. 1 (2004), p. 1-8. CCC (1,056 – IF2004)

[18] ŠTEFÁNIK, P. – HUDCOVIČ, P. – ŠEBO, P. Influence of volume fraction and orientation of carbon fibres on heat transfer in unidirectional copper matrix composites. In *Kovove materialy-Metallic Materials.* Vol. 42, no. 5 (2004), p. 329-338. CCC (1,056 – IF2004)

[19] VAŇO, A. – PELACHOVÁ, T. Vplyv tepelného spracovania na mikroštruktúru dendritov usmernene kryštalizovanej polyfázovej intermetalickej zliatiny na báze niklu. In *Kovove materialy-Metallic Materials.* Vol. 42, no. 2 (2004), p. 121-131. CCC (1,056 – IF2004)

[20] BALOG, M. – NAGY, J. – SIMANČÍK, F. – IŽDINSKÝ, K. – ŠVEC, P. – JANIČKOVIČ, D. Heat resistant Al based profiles possessing high strength at elevated temperatures. In *Kovove materialy-Metallic Materials.* Vol. 44, no. 6 (2006), p. 341-349. CCC (IF2005 – 0,973)

[21] IŽDINSKÝ, K. – SIMANČÍK, F. – KORÁB, J. – KRAMER, I. – ŠTEFÁNIK, P. – KAVECKÝ, Š. – ŠRÁMKOVÁ, T. – CSUBA, A. – ZEMÁNKOVÁ, M. Preparation and thermophysical properties of Cu alloy/high thermal conductivity carbon fibre composites. In *Kovove materialy-Metallic Materials.* Vol. 44, no. 6 (2006), p. 327-334. CCC (IF2005 – 0,973)

[22] ŠEBO, P. – ŠTEFÁNIK, P. Effect of In addition on Sn-Ag solder, wetting and shear strength of copper joints. In *Kovove materialy-Metallic Materials.* Vol. 43, no. 3 (2005), p. 202-209. CCC (IF2005 – 0,973)

[23] KOVÁČIK, J. Correlation between Poisson's ratio and porosity in porous materials. In *Journal of Materials Science.* Vol. 41, no. 4 (2006), p. 1247-1249. CCC (IF2005 – 0,901)

[24] STEIN, G.J. – MÚČKA, P. – CHMÚRNY, R. Preliminary results on an x-direction apparent mass model of human body sitting in a cushioned suspended seat. In *Journal of Sound and Vibration.* Vol. 298, no. 3 (2006), p. 688-703. CCC (IF2005 – 0,898)

[25] MÜLLEROVÁ, K. – KOVÁČIK, J. – SIMANČÍK, F. – ŠVEC, P. Al-based systems with unusual mechanical and transport properties. In *Physica Status Solidi B - Basic Research.* Vol. 242, no. 3 (2005), p. 637-644. CCC (0,836 – IF2005)

[26] IHLÁROVÁ, I. – JACOBSEN, F. An approximate method of modelling scattering by composite bodies. In *Journal of Sound and Vibration*. Vol. 262, no. 5, (2003), p. 1235-1241. CCC, (0,724 IF2003)

[27] KUDLIČKA, J. Energy flow of axisymmetric elastic waves in a three-layered, transtropic-isotropic-transtropic, composite cylinder. In *Journal of Sound and Vibration.* Vol. 277, nos. 1-2 (2004), p. 1093-1100. CCC (0,828 – IF2004)

[28] KUDLIČKA, J. Dispersion of torsion vawes in a thick-walled transversely isotropic circular cylinder of infinite length. In *Journal of Sound and Vibration*. Vol. 294, nos. 1-2 (2006), p. 368-373. CCC (0,898 – IF2005)

[29] KOŠÚT, J. Quadratic damage rule in random loading case. In *Fatigue and Fracture of Engineering Materials and Structures.* Vol. 27, no. 8 (2004), p. 679-700. CCC (0,673 – IF2004)

[30] MURIN, J. Some properties of a Diesel drive line with hydrodynamic tirque convertors of the latest generation. In *Mechanism and Machine Theory.* Vol. 40, no. 1 (2005), p. 99-117. CCC (0,607 – IF2005)

[31] IŽDINSKÝ, K. – DUFEK, J. – IVAN, J. – ZEMÁNKOVÁ, M. – MINÁR, P. – IŽDINSKÁ, Zita Microstructure of air plasma-sprayed NiAl coating. In *Kovove materialy-Metallic Materials.* Vol. 41, no. 6 (2003), p. 365-376. CCC (0,563 – IF2003)

[32] IŽDINSKÝ, K. – IŽDINSKÁ, Z. – DUFEK, J. – IVAN, J. – ZEMÁNKOVÁ, M. Microstructure of ball-milled NiAl30 powder. In *Kovove materialy-Metallic Materials.* Vol. 41, no. 2 (2003), p. 106-117. CCC (0,563 – IF2003)

[33] ŠEBO, P. – MARUNOVÁ, G. – ŠTEFÁNIK, P. – KAVECKÝ, Š. Vplyv množstva a orientácie uhlíkových vlákien na abrazívne opotrebenie kompozitného materiálu s medenou matricou. In *Kovove materialy-Metallic Materials.* Vol. 41, no. 4(2003), p. 248–256. CCC (0,563 – IF2003)

[34] KÚDELA, S. – WENDROCK, H. – KÚDELA, S. Jr. – PTÁČEK, L. – MENZEL, S. – WETZIG, K. Effect of interfaces on fibre fracture in Mg and MgLi matrix composites. In *Materials Science Forum.* Vol. 482, (2005), p. 355-358. (0,399 – IF2005)

[35] MURIN, J. A controlled diesel drive line with hydrostatic transmission: Part 1-mathematical model. In *International Journal of Vehicle Design.* Vol. 38, nos. 2-3 (2005), p.109-122. CCC (0,340 – IF2005)

[36] MURIN, J. A controlled diesel drive line with hydrostatic transmission: Part 2 – dynamic properties at periodic loading. In *International Journal of Vehicle Design.* Vol. 38, nos. 2-3 (2005), p. 123-138. CCC (0,340 – IF2005)

[37] MÚČKA, P. Road waviness and the dynamic tyre force. In *International Journal of Vehicle Design.*Vol. 36*,* nos. 2/3 (2004), p. 216-232. CCC (0,245 – IF2004)

[38] STEIN, George Juraj – MÚČKA, Peter Theoretical investigation of a linear planar model of a passenger car with seated people. In *Proceedings of the Institution of Mechanical Engineers Part D: Journal of Automobile Engineering*. Vol. 217, no. 4(2003), p. 257-268. CCC (0,239 – IF2003)

[39] BALOG, M. – NAGY, J. – IŽDINSKÝ, K. – SIMANČÍK, F. Compaction of ultra-fine Al powders. In *International Journal of Materials and Product Technology.* Vol. 23*,* nos. 1-2 (2005), p. 69-78. (0,206 – IF2005)

[40] NAGY, J. – BALOG, M. – IŽDINSKÝ, K. – SIMANČÍK, F. High strength potential of aluminium nanocopmposites reinforced with nonperiodical phases. In *International Journal of Materials and Product Technology.* Vol. 23*,* nos. 1-2 (2005), p. 79-90. (0,206 – IF2005)

***ii. List of monographs/books published abroad***

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***iii. List of monographs/books published in Slovakia***

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### *iv. List of other scientific outputs specifically important for the Organisation*

As the Institute's activities in fundamental research in assessed period were to a large extent performed within research contracts with industrial partners or in a frame of three large research projects of the 5 and 6 FP EU (all included large industrial participation), many scientific results could not be published in open literature, because of existing non-disclosure agreements. These results however can be found in plenty of progress reports completed for industrial partners (Alulight, Eff-Power, Elektrokarbon, SHW, Gleich, Skoda výskum, etc.), as well as for European Community.

### **v.** *Table of research outputs*

*Table* ***Research outputs*** *shows research outputs in number of specified entries; these entries are then divided by FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).*

| Research outputs | 2003 | | | 2004 | | | 2005 | | | 2006 | | | total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | averaged number per year | av. No. / FTE | av. No. / salary budget |
| chapters in monographs, books published abroad | 3 | 0,09 | 0,18 | 0 | 0,00 | 0,00 | 2 | 0,05 | 0,12 | 0 | 0,00 | 0,00 | 5 | 1,3 | 0,03 | 0,07 |
| chapters in monographs, books published in Slovakia | 0 | 0,00 | 0,00 | 0 | 0,00 | 0,00 | 0 | 0,00 | 0,00 | 0 | 0,00 | 0,00 | 0 | 0,0 | 0,00 | 0,00 |
| CC publications | 16 | 0,47 | 0,97 | 23 | 0,65 | 1,38 | 14 | 0,37 | 0,86 | 18 | 0,45 | 0,99 | 71 | 17,8 | 0,48 | 1,05 |
| scientific publications indexed by other databases (WOS, JCR) | 0 | 0,00 | 0,00 | 0 | 0,00 | 0,00 | 4 | 0,11 | 0,24 | 0 | 0,00 | 0,00 | 4 | 1,0 | 0,03 | 0,06 |
| scientific publications in other journals | 14 | 0,41 | 0,85 | 10 | 0,28 | 0,60 | 5 | 0,13 | 0,31 | 3 | 0,08 | 0,17 | 32 | 8,0 | 0,22 | 0,47 |
| publications in proc. of international scientific conferences | 35 | 1,02 | 2,12 | 17 | 0,48 | 1,02 | 26 | 0,69 | 1,59 | 31 | 0,78 | 1,71 | 109 | 27,3 | 0,74 | 1,61 |
| publications in proc. of nat. scientific conferences | 4 | 0,12 | 0,24 | 6 | 0,17 | 0,36 | 4 | 0,11 | 0,24 | 6 | 0,15 | 0,33 | 20 | 5,0 | 0,14 | 0,30 |
| active participations at international conferences | 45 | 1,31 | 2,73 | 40 | 1,13 | 2,39 | 40 | 1,06 | 2,44 | 52 | 1,31 | 2,86 | 177 | 44,3 | 1,20 | 2,61 |
| active participations at national conferences | 5 | 0,15 | 0,30 | 4 | 0,11 | 0,24 | 3 | 0,08 | 0,18 | 19 | 0,48 | 1,05 | 31 | 7,8 | 0,21 | 0,46 |

Note: according to annual report 2006 number of CC publications in 2006 includes besides 18 publications also 5 publications available only on line at the internet (these will be published in printed version in 2007). Total value: 18 + 5 = 23.

### *vi. List of patents and patent applications (issued or applied in assessed period)*

**Patent applications in assessed period:**

[1] Method for strengthening a component consisting of a deformable cellular material, said component and the use thereof.
Inventors: SIMANČÍK, FRANTIŠEK – JERZ, JAROSLAV,
Applicant: Institute of Materials and Machine Mechanics SAS (SR).
Original application on 4.4.2003 - SK20030000425, Publication number: SK4252003
PCT application on 1.4.2004 - WO2004EP50419 JP20060505512T, Publication number: WO2004087981, EP1611262, JP2006523536T
Status: EP grant intended (decision published 2006)

[2] Method and device for producing dimensionally accurate foam. (Production of foamed bodies, to accurate dimensions as lightweight structural components and panels, uses metal semi-finished powder metallurgy products to be heated in a mold with radiation to trigger foaming.)
Inventors: RAJNER, WALTER – SIMANČÍK, FRANTIŠEK,
Applicant: Alulight International GmbH Ranshofen (Austria.)
Original application on 25.3.2003 - DE20031013321 Publication number: DE10313321
PCT application on 25.3.2004 - WO2004EP03183, EP200407230198, CA20042519964, AT20040723198T, JP20060504866T Publication numbers: WO2004085688, EP1608476, CA2519964, AT353260T, JP2006521467T
Status: DE10313321 patent granted 15.7.2004
JP2006521467T patent granted 21.9.2006
EP1608476 patent granted 7.2.2007
AT353260T patent granted 15.2.2007

[3] Process for producing lightweight-building panels out of two metal sheets, which are joined with each other and an insulating core.
Inventors: GLEICH, GUENTHER. – SIMANČÍK, FRANTIŠEK,
Applicant: GLEICH GmbH (Germany).
Original application on 24.2.2005 - DE200510008447
EP application on 24.2.2005 - EP20060004976, Publication number: EP1695779

**Granted patents in assessed period:**

[4] Method for producing foamed metal composites
Inventors: SIMANČÍK, FRANTIŠEK – WÖRZ, HELMUT - WOLFSGRUBER, ERIC
Applicant: Alulight International GmbH Ranshofen (Austria.)
Original application on 9.4.1998 - AT19980000625, Publication number: AT 62598
PCT application on 9.4.1999 – WO99/052661, EP19990912961 19990409 Publication numbers: EP1085956, US 6391250, AU3126699, CA2326784, ES2209413, AT408317, DE59907205, JP2002511526
Status: JP2002511526T patent granted 16.4.2002,
US6391250 patent granted 21.5.2002,
EP1085956 patent granted 1.10.2003,
AT251001T patent granted 15.10.2003,
DE59907205D patent granted 6.11.2003,
ES2209413T patent granted 16.6.2004,

[5] Metal matrix fiber reinforced composite material and its preparation.
Inventors: DEGISCHER, H.P. – DANNINGER, H. – KRISZT, B. – PONEMAYR, H. – DAXELMLLER, M. – POECKL, G. – CONSEMUELLER, K. – HRIBERNIK, B. – SIMANČÍK, F. – IŽDINSKÝ, K.,
Applicant: Böhler Uddeholm Aktiengesellschaft (Austria)

Original application on 10.4.1999 - AT19990000696
Status: EP1046724 patent granted 12.10.2005,
AT306570T patent granted 15.10.2005,
DK1046724T patent granted 6.2.2006,
DE50011313D patent granted 23.2.2006,
ES2250095T patent granted 16.4.2006,
SI1046724T patent granted 30.4.2006,

[6] Compounds Cu-C, Ag-C and Au-C for sliding electric contacts with the highest current density. (Zmesi Cu-C, Ag-C a Au-C na aplikáciu na klzné elektrické kontakty s najvyššou prúdovou hustotou.)
Inventors: BIELEK, JOZEF – EMMER, ŠTEFAN – KOVÁČIK, JAROSLAV
Applicant: Faculty of Electrical Engineering and Information Technology SUT (SR).
Original application on 14.8.1992- SK19920002502
Status: SK250292 patent granted 3.11.2005

### *vii. Supplementary information and/or comments on the scientific output of the Organisation*

It should be noted, that almost 90% of institute's research employees graduated in engineering (mostly mechanical engineering). Moreover, only 50% of them possess also higher scientific degree level. This is why the research activities are often oriented towards solving of technological and user-oriented problems instead of towards pure fundamental research. This attitude naturally leads to limited publication activity in open literature – the unique results are mostly transferred into comprehensive institute's know-how, which is used in many industrial projects and can be documented in many progress reports or by grants of 17 international patents in reporting period. From this point of view the publication activity can be regarded as satisfactory and saturated.

## 2. Responses to the scientific output

*Table **Citations** shows specified responses to the scientific outputs; these entries are then divided by the FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).*

| Citations | 2002 | | | 2003 | | | 2004 | | | 2005 | | | total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | averaged number per year | av. No. / FTE | av. No. / salary budget |
| Web of Science | 77 | 2,2 | 4,7 | 106 | 3,0 | 6,3 | 119 | 3,2 | 7,3 | 100 | 2,5 | 5,5 | 402 | 100,5 | 2,7 | 5,9 |
| Scopus | 0 | 0,0 | 0,0 | 13 | 0,4 | 0,8 | 19 | 0,5 | 1,2 | 12 | 0,3 | 0,7 | 44 | 11,0 | 0,3 | 0,6 |
| (specify Database 1) | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 | 0,0 |
| in monographs, conf. proceedings and other publications abroad | 28 | 0,8 | 1,7 | 24 | 0,7 | 1,4 | 10 | 0,3 | 0,6 | 20 | 0,5 | 1,1 | 82 | 20,5 | 0,6 | 1,2 |
| in monographs, conf. proceedings and other publications in Slovakia | 25 | 0,7 | 1,5 | 62 | 1,7 | 3,7 | 20 | 0,5 | 1,2 | 5 | 0,1 | 0,3 | 112 | 28,0 | 0,8 | 1,7 |

### *i. List of 10 top-cited publications and number of their citations in the assessment period:*

[1] MARKUŠ, Š. *The mechanics of vibrations of cylindrical shells.* Amsterdam: Elsevier, 1988. (WOS citations: 25; other publications – abroad: 1)

[2] MATEJKA, D. – BENKO, B. *Plasma spraying of metallic and ceramic materials.* Chichester: J.Wiley, 1989. (WOS citations: 14)

[3] JANIČKOVIČ, D. – ŠEBO, P. – DUHAJ, P. – ŠVEC, P. The rapidly quenched Ag-Cu-Ti ribbons for active joining of ceramics. In *Materials Science and Engineering A.* Vol. A304-306, no. SI (2001), p. 569-573. (WOS citations: 14)

[4] SIMANČÍK, F. Reproducibility of aluminium foam properties. In *Metal Foams and Porous Metal Structures.* Bremen: MIT Verlag, 1999, p. 235-240. (WOS citations: 6; other publications – abroad: 7, in Slovakia: 1)

[5] MAZÚCH, T. – HORÁČEK, J. – TRNKA, J. – VESELÝ, J. Natural modes and frequencies of a thin clamped-free steel cylindrical storage tank partially filled with water: FEM and measurement. In *Journal of Sound and Vibration.* Vol. 193, no. 3 (1996), p. 669-690. (WOS citations: 12; other publications – abroad: 1)

[6] LAPIN, J. Comparative study of microstructural and mechanical properties of two directionally solidified intermetallic nickel-based alloys. In *Kovove materialy-Metallic Materials.* Vol. 40, no. 4 (2002), p. 209-221. (WOS citations: 5; other publications – abroad: 1, in Slovakia: 5)

[7] PÁLKA, V. – POŠTRKOVÁ, E. – KOERTEN, H.K. Some characteristics of hydroxylapatite powder particles after plasma spraying. In *Biomaterials.* Vol. 19, no. 19 (1998), p. 1763-1772. (WOS citations: 11)

[8] KOVÁČIK, J. – SIMANČÍK, F. Aluminium foam – modulus of elasticity and electrical conductivity according to percolation theory. In *Scripta Metallurgica.* Vol. 39, no. 2 (1998), p. 239-246. (WOS citations: 6; SCOPUS citations: 3; other publications – in Slovakia: 1)

[9] DUHAJ, P. – ŠEBO, P. – ŠVEC, P. – JANIČKOVIČ, D. Development and characterisation of Ag-Cu-Ti brazes prepared with planar flow casting. In *Materials Science and Engineering A.* Vol. A271, nos. 1-2 (1999), p. 181-187. (WOS citations: 9; SCOPUS citations: 1)

[10] MARKUŠ, Š. – NÁNÁSI, T. Vibration of curved beams. In *The Shock and Vibration Digest.* Vol. 13, no 4 (1981), p. 3-14. (WOS citations: 10)

***ii. List of top-cited authors from the Organisation (at most 10 % of the research employees) and their number of citations in the assessment period:***

[1] SIMANČÍK, F. – 93 citations (WOS citations: 50; SCOPUS citations: 5; other publications – abroad: 32, in Slovakia: 6),

[2] LAPIN, J. – 82 citations (WOS citations: 62; SCOPUS citations: 5; other publications – abroad: 5, in Slovakia: 10)

[3] MARKUŠ, Š. – 78 citations (WOS citations: 63; SCOPUS citations: 9; other publications – abroad: 4, in Slovakia: 2)

[4] KOVÁČIK, J. – 58 citations (WOS citations: 38; SCOPUS citations: 6; other publications – abroad: 10, in Slovakia: 4)

[5] ŠEBO, P. – 56 citations (WOS citations: 52; SCOPUS citations: 2; other publications – abroad: 0, in Slovakia: 2)

***iii. Supplementary information and/or comments on responses to the scientific output of the Organisation***

Some citations are related to our former workers. In this case only citations of works that had been completed at the institute are assigned.

It should be noted that to a positive response to Institute's research activities also belong:

- Membership of Institute in the Centre of excellence of SAS for the research on nanostructured materials NANOSMART. Based on the excellent results the funding of the Centre was extended for another 4 years term
- Award of prestigious 2006 annual price of Slovak Academy of Sciences for the research on aluminium foam.
- 25 invited lectures to international conferences/scientific events during reported period
- grant of 17 international patents during reported period (based on 6 patent applications)

## 3. Research status of the Organisation in the international and national context

### International/European position of the Organisation

***i. List of the most important research activities documenting international importance of the research performed by the Organisation, incl. major projects (details of projects should be supplied under Indicator 4). Collective membership in the international research organisations, in particular within the European Research Area***

Main research activities of IMSAS in reported period and obtained results were in more details presented in the Chapter II of this questionnaire.
As can be seen Institute has an ambition to be competitive at least on European level. Therefore almost all research work is performed within bilateral or multilateral international cooperation with recognised research institutions as well as with leading industrial partners.
The main research topics, where IMSAS activities can be considered as internationally fully competitive are:

[1] **Metal matrix composites and technologies for their manufacturing**

In this field the international competence of IMSAS was recognized by the invitation into consortium of integrated project ExtreMat within 6th FP EU. Institute is one of the leading members active in 3 work packages and coordinating 16 partners (funding ~ 5 mil. €) in one of 4 subprojects SP3 devoting to the development of novel heat sink materials. The most important partners closely cooperating with IMSAS within this subproject are well recognized R&D organizations including ARCS - Austrian Research Centre Seibersdorf, CEIT - San Sebastian, DLR – Bonn, EADS – Ottobrun, EMPA - Thun, EPFL - Lausanne, FZJ – Jülich, IFAM FhG - Dresden, INASMET-San Sebastian , IPP-Max Planck - Garching, Plansee AG - Reutte, Siemens AG - Munich, TU-Vienna, TU-Warsaw, University of Alicante.

Beside common research activities within Extremat project IMSAS activities in MMC have been devoted also to bilateral (contractual) cooperations with several foreign industrial partners:

- Development of the manufacturing of ceramic/lead composites by the melt infiltration process for the battery applications - EFF - Power, Hisings Backa, Sweden (contracted)
- Development of the technology for galvanic coating of carbon fibres with nickel (INCO, Canada)
- Development of novel heat sinks for power electronics – Plansee, Reutte Austria (contract negotiations)

IMSAS has got an invitation to join consortium for preparation of research proposal for next call in 7$^{th}$ FP EU devoted to the development of MMC for extreme conditions.

[2] **Intermetallic alloys for high-temperature applications**

Similarly as in previous case IMSAS plays important role also in the European research on this topic mainly via coordination of workpackage WP 2a: “Fundamentals of solidification on earth and space” (6 partners, funding: 1,300.000,- €) in a frame of another integrated project IMPRESS of the 6th FP EU. Up to 45 research organizations from 15 EU countries are involved in this project anchoring thus the

research in the solid base of ERA. The most important and closely cooperating research partners include: European Space Agency (NL); Leibnitz Inst. for Solids and Mat. Research, Dresden (D); Inst. Nat. Polytech. Lorraine (F); University of Cambridge (UK); Inst. of Structural and Macrokinetics and Mat. Sci., Moskow (RUS); EPFL Lausanne (CH), DLR Bonn (D); IRC - University of Birmingham, (UK); IFAM FhG Bremen (D); etc.
Results obtained in the research on intermetallics are frequently exchanged and discussed also in a frame of two COST projects:

- Evolution and degradation of microstructure of CMSX4 superalloy during ageing and creep exposure (COST project No. 538)
- Solidification behaviour and creep of gamma titanium aluminides (COST project No. 522/29202)

In this research field IMSAS has already got two invitations to join consortia for preparation of research proposal for next call within 7$^{th}$ FP EU.

[3] **Research on metal foams**

In this field IMSAS contractually cooperates mainly with foreign industrial partners in a frame of exclusive long term research projects:

- Development of powdermetalurgical (PM) aluminium foams Alulight (bilateral cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria and Mepura, Ltd., Ranshofen since 1993)
- Development of structural components using aluminium foam ALPORAS and investigation of their application possibilities (bilateral cooperation with GLEICH GmbH Metallplatten-Service, Kaltenkirchen, Germany)
- A pilot study on the possibility to model the properties of aluminium foam by finite element modelling. (Research contract from Alulight Deutschland GmbH, Wasseralfingen, Germany)..

Beside this some activities were performed within project funded by United States Army Research Laboratory - European Research Office devoted to *“Use of Al foam to reduce the transfer of impact stress between ceramic plates”*

In the research on aluminium foams IMSAS belongs to leading European institutions, what can be illustrated e.g. by many invitations to most important international conferences (among them 3 opening plenary lectures) and more than 15 granted international patents. IMSAS also significantly contributed to the development of all three well-known serial automotive applications of aluminium foam (side rail stiffener in Audi 2, profile stiffener in Ferrari Modena and crash absorber in Audi Q7)

[4] **Advanced vibration control**

The international competence of IMSAS in the field of vibration control was recognised in a frame of joint research project VIBSEAT within 5th FP EU. 9 leading organisation in this branch from 5 European countries (United Kingdom, Germany, France, Austria, Sweden) cooperated with our Institute on the improvement of vehicle driver’s protection against whole-body vibration.

[5] **Development of lead-free solders**

IMSAS takes important part also in the research devoted to the development of lead free solder materials. The international cooperation is mostly performed via information and results exchange within COST action “Lead-free Solder Materials”

(COST project No. 531.1, 51-98-9345-00/2002) and participation in European Lead-Free Soldering Network (Coordination Action of the 6th FP EC, Acronym: ELFNET, NMP2-CT-2003-505504)

### ii. List of international conferences (co-) organised by the Organisation

[1] International conference "*MATRIB 2005 - Materials, Tribology, Processing*", 23rd - 25th June 2005, Vela Luka, Croatia.

[2] International conference "*MATRIB 2006 - Materials, Tribology, Processing*", 22nd - 24th June 2006, Vela Luka, Croatia.

[3] International Conference "*Advanced Metallic Materials and their Joining*", 25th - 27th October 2004, Bratislava, Hotel Holiday Inn.

[4] International Conference *"Advanced Metallic Materials"*, 5th - 7th November 2003, KC SAV Smolenice, 103 participants from 17 countries (Slovakia, Czech Republic, Germany, Austria, Poland, South Korea, Greece, Croatia, Belgium, Italy, Netherlands, Russia, Switzerland, Great Britain and Ukraine).

[5] International Conference NMCM 2003 - IX-th Conference on Numerical Methods in Computer Mechanics, University of Žilina, 9th - 12th September 2003.

[6] 8th International Acoustic Conference "Noise and vibration in practice", 2nd - 3rd June 2003, Kočovce.

[7] 9th International Acoustic Conference "Noise and vibration in practice", 1st - 2nd June 2004, Kočovce.

[8] "*International conference on advanced materials micro- and nanotechnology - CAMIN 2005*", 27th – 29th April 2005, KC SAV v Smolenice.

[9] 10th International Acoustic Conference "Noise and vibration in practice", 6th - 8th June 2005, Kočovce.

[10] 11th International Acoustic Seminar "Noise and vibration in practice", 1st - 2nd June 2006, Kočovce.

[11] International conference "*Advanced in Nanostructured Materials, Processing - Microstructure - Properties - NANOVED 2006 - NENAMAT*", 14th - 17th May 2006, KC SAV Stará Lesná.

### iii. List of international journals edited/published by the Organisation

[1] **Kovové materiály-Metallic Materials,**
Journal publishes original and experimental works devoted to structure, properties and processing of metallic and selected non-metallic materials
published since: 1963 bimonthly, ISSN: 0023-432X,
language: English,
cited by: Materials Science Citation Index (MSCI), Institute for Scientific Information, Philadelphia, USA, Impact Factor (ISI Journal Citation Reports 2004: 1.056 and 2005: 0.973),
According to the Impact Factor 2005, the journal is on the 15th position among 67 CC journals in the field of metallurgy and metallurgical engineering world-wide and on the 1st position among all of 17 CC journals published in Slovakia.
URL: http://www.kovmat.sav.sk/.

[2] **Strojnícky časopis - Journal of Mechanical Engineering,**

The Journal is dedicated entirely to the full range of science and technology associated with machine dynamics,
published since: 1950 bimonthly, ISSN: 0039-2472,
language: Slovak/Czech and English,
scaned by: Shock and Vibration Digest, Sage Publications, Inc., Thousand Oaks, CA, U.S.A a Applied Mechanics Reviews (Journal of the American Society of Mechanical Engineers), Fairfield, NJ, U.S.A.),
URL: http://www.strojcas.sav.sk/.

[3] **Powder Metallurgy Progress,**
Journal of science and technology of particle materials, published by Institute of Materials Research SAS Košice, Institute of Materials & Machine Mechanics SAS and Miba Slovakia, s.r.o., Dolný Kubín.
URL: http://www.imr.saske.sk/umv/pmp.htm.

**iv. List of edited proceedings from international scientific conferences and other proceedings**

[1] Advanced metallic materials: proceedings of the international conference, November, 5 – 7, 2003, Smolenice. Ed. J. Jerz, P. Šebo and M. Zemánková. Bratislava: IMMM SAS, 2003, 316 p. ISBN 80969011-7-6. (+CD)

[2] Noise and vibration in practice: proceedings of the 8th international acoustic conference, June, 2 – 3, 2003, Kočovce. Ed. S. Žiaran. Bratislava: STU, ÚMMS SAV, SSTP, SAS, 2003. 111 p.

[3] Advanced metallic materials and their joining: proceedings of the international conference, Bratislava, 25 – 27 October 2004. Ed. P. Brziak, A. Jajcay. Bratislava: VÚZ PI, ÚMMS SAV, SNMTS, 2004. (CD)

[4] Noise and vibration in practice: proceedings of the 9th international acoustic conference, Kočovce, 1- 2 June 2004. Ed. S. Žiaran. Bratislava: SSTP, SKAS, SjF STU, ÚMMS SAV, 2004. 114 p. ISBN 80-227-2066-6.

[5] Noise and vibration in practice: proceedings of the 10th international acoustic conference, Kočovce, 6-8 June 2005. Ed. S. Žiaran. Bratislava: SUT, SAS, IMMM SAS, 2005. 118 p. ISBN 80-227-2245-6.

[6] International Conference Advances in Nanostructured Materials, Processing – Microstructure – Properties NANOVED 2006 – NENAMAT, Stará Lesná, May 14-17, 2006. Košice: IMR SAS, IMMM SAS, 2006.

## National position of the Organisation

***i. List of selected most important national projects (Centres of Excellence, National Reference Laboratories, Agency for the Promotion of Research and Development (APVV/APVT), National Research Programmes, Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA), and others)***

**Centre of the Excellence - Slovak Academy of Sciences**

[1] Centre for the research on nanostructural materials (NANOSMART)
Head of the project: Doc. RNDr. J. Dusza, DrSc. - IMR SAV, Košice
Principal investigator from IMMM SAS: RNDr. Ing. S. Kúdela, PhD.
Duration: 10/2002 - 9/2006, due to the success project was prolonged until 2010

**Most important national projects funded by Agency for Promotion of Reseach and Development:**

[2] Bulk nanostructured metallic materials for structural applications
(Project No.: APVT-51-021102)
Head of the project: Dr. Ing. F. Simančík
Duration: 1/2003 - 12/2005

[3] Development of structural profiles from extruded powders of aluminium alloys with unique properties
(Project No.: APVT-51-031204)
Co-operation with: SAPA Profiles a.s., Žiar nad Hronom
VÚZ – PI SR (Welding Research Institute), Bratislava
Head of the project: Dr. Ing. F. Simančík
Duration: 1/2005 - 12/2007

Further projects funded by Agency for Promotion of Research and Development are described in section 4. - Project structure - National projects and funding.

**Project funded by Scientific Grant Agency of ME SR and SAS - VEGA**

[6] Physical-metallurgical relations in lead-free solders structure and their interfaces in joints
(Project No.: VEGA 2/6160/26)
Head of the project: RNDr. P. Šebo, DrSc.
Duration: 1/2006 - 12/2008

[7] Vibration mitigation of driver-operator in fore-and-aft direction by passive, active or semi-active vibration control systems
(Project No.: VEGA 2/6161/26)
Head of the project: Ing. J. Stein, PhD.
Duration: 1/2006 - 12/2008

[8] Vibrating mechanical systems modelling for the purpose multidimensional power flow analysis from energy point of view and with utilizing of power flow paths theory
(Project No.: VEGA 2/6169/26)
Head of the project: RNDr. E. Wiszt, PhD.
Duration: 1/2006 - 12/2008

[9] Influence of interactions between components on the structure and properties of magnesium based composite materials
(Project No.: VEGA 2/5138/25)
Head of the project: RNDr. Ing. S. Kúdela, PhD.
Duration: 1/2005 - 12/2007

[10] Methodology of fatigue life and fatigue reliability assessment of mechanical structures under service load conditions
(Project No.: VEGA 2/4162/04)
Head of the project: Ing. V. Kliman, DrSc.
Duration: 1/2004 - 12/2006

[11] Investigation and modelling of the mechanical properties of aluminium foam matrix composites
(Project No.: VEGA 2/4164/04)
Head of the project: Dr. Ing. J. Kováčik
Duration: 1/2004 - 12/2006

[12] Preparation of multilayered barrier coatings using plasma and physical deposition and studies of their properties with respect to preparation parameters and microstructure
(Project No.: VEGA 2/4165/04)
Head of the project: Ing. Š. Kavecký, PhD.
Duration: 1/2004 - 12/2006

[13] Microstructural aspects of the strength and ductility of multiphase titanium and nickel based intermetallic alloys
(Project No.: VEGA 2/4166/04)
Head of the project: Ing. J. Lapin, PhD.
Duration: 1/2004 - 12/2006

[14] Power flow paths and energy transfer in mechanical systems
(Project No.: VEGA 2/3205/23)
Head of the project: RNDr. E. Wiszt, PhD.
Duration: 1/2003 - 12/2005

[15] Reconstruction of nonconservative dynamic systems
(Project No.: VEGA 2/4161/04)
Head of the project: Ing. T. Mazúch, PhD.
Duration: 1/2004 - 6/2005

[16] Interactions between components and interfaces in magnesium based composite materials
(Project No.: VEGA 2/2078/22)
Head of the project: RNDr. Ing. S. Kúdela, PhD.
Duration: 1/2002 - 12/2004

[17] Optimization of properties and joining of metal matrix composites
(Project No.: VEGA 2/1046/23)
Head of the project: RNDr. P. Šebo, DrSc.
Duration: 1/2001 - 12/2003

[18] Variant modelling of stress wave propagation in impacted bodies by use of finite element method
(Project No.: VEGA 2/1043/23)
Head of the project: Ing. T. Mazúch, PhD.
Duration: 1/2001 - 12/2003

[19] Development and properties of multiphase intermetallic alloys for structural applications
(Project No.: VEGA 2/1044/21)
Head of the project: Ing. J. Lapin, PhD.
Duration: 1/2001 - 12/2003

[20] Development of metallic foams based on zinc and its alloys and measurement of their properties with respect to the received porosity

(Project No.: VEGA 2/1144/23)
Head of the project: Dr. Ing. J. Kováčik
Duration: 1/2001 - 12/2003

[21] Evaluation and estimation of the effective physical parameters of desired composite systems for the electrical applications by using of the approaches of statistical topography and percolation theory
(Project No.: VEGA 1/8304/23)
Head of the project: Ing. J. Bielek, PhD. - FEI STU Bratislava
Principal investigator from IMMM SAS: Dr. Ing. J. Kováčik
Duration: 1/2001 - 12/2003

[22] Evaluation and estimation of the effective physical parameters of desired composite systems for the electrical applications by using of the approaches of statistical topography and percolation theory
(Project No.: VEGA 2/1045/23)
Head of the project: Ing. Vladimír Kliman, DrSc.
Duration: 1/2001 - 12/2003

### *ii. List of national scientific conferences (co)-organised by the Organisation*

[1] **New materials and technologies**, 9th - 10th October 2006, KC SAS Smolenice- seminar oriented to support knowledge transfer in the field of modern materials, technologies and designing into industrial practice.

[2] **Modern light structural materials**, 7th November 2006, IMMM SAS, Bratislava, all-day seminar oriented to new developments in the field of modern light-weight materials and structures.

[3] **Vibration control**, 14th December 2006, IMMM SAS Bratislava, all-day seminar oriented to vibration control of mechanical structures, computerised measurement and analysis of vibrations and influence of vibrations on human body.

[4] **Mechanical destructive and metallographic investigation of materials**, 16th March 2005, IMMM SAS, all-day seminar organized by IMMM SAS, Society for Material Science at SAS and Welding Research Institute, Bratislava.

[5] **Lead-free solders for electrotechnics,** 20th September 2005, MtF STU, all-day conference organized by IMMM SAS, MtF STU and Institute of Physics SAS, Bratislava.

[6] **Improvement of vehicle drivers protection against whole-body vibration**, Lector: J. G. Stein, 20th April 2006, IMMM SAS.

[7] **High-strength profiles based on aluminium alloys**, Lectors: M. Balog, J. Nagy, K. Iždinský, F. Simančík, 10th February 2005, IMMM SAS.

[8] **Practical application of advanced non-linear models of driver's seats suspension systems**, Lector: J. G. Stein, R. Zahoranský, 10th March 2005, IMMM SAS.

[9] **Introduction to the theory of quasicrystals**, Lector: M. Krajči (Institute of Physics), 14th April 2005, IMMM SAS.

[10] **Titanium based intermetallic alloys for hight-temperature structural applications**, Lector: J. Lapin, T. Pelachová, O. Bajana, 26th May 2005, IMMM SAS.

[11] **Thermal dilatation of short fibre reinforced magnesium matrix composites**, Lector: S. Kúdela Jr., 16th June 2005, IMMM SAS.

[12] **Using of Cambridge Engineering Selector for structural design**, Lector: J. Čačko, 7th July 2005, IMMM SAS.

[13] **Lead-free solders**, Lector: P. Šebo, 29th September 2005, IMMM SAS.

[14] **Composite materials prepared by hot pressure infiltration**, Lector: J. Koráb, 10th November 2005, IMMM SAS.

[15] **Measurement of the thermal conductivity of metal matrix composites by "flash" method**, Lector: T. Šrámková (Institute of Physics), 1st December 2005, IMMM SAS.

***iii. List of national journals published by the Organisation***

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***iv. List of edited proceedings of national scientific conferences/events***

[1] „Mechanické – deštruktívne a metalografické skúšanie kovov – Normy EN a ISO", 16th March 2005, IMMM SAS, proceedings of the seminar organized by IMMM SAS, Society for Material Science at SAS and Welding Research Institute, Ed. by P. Štefánik, IMMM SAS, 2005.

[2] Konštrukčné materiály 2003: Proceedings of 4. scientific conference, 6.5.2003, Bratislava. VSNK SR, ÚMMS SAV, HF TU, ZHŤPG SR, 2003, 66 pgs.

## International/European position of the individual researchers

### *i. List of invited/keynote presentations at international conferences, documented by an invitation letter or programme*

[1] SIMANČÍK, F. Automotive Entwicklungen in der Westslowakei (PSA/KIA usw.) und interregionale Technologiepositionen. Presentation of Frank Stronach Institute and trends in the automotive sector, Graz, 13.-14. October 2005.

[2] SIMANČÍK, F. Nanostructured metals with extraordinary mechanical properties. International conference on advanced materials micro- and nanotechnology, Smolenice, 27.-29. April 2005.

[3] SIMANČÍK, F. Porous materials: PM aluminium foams. Design and capabilities of PM components and materials, Aachen, 3.-11. September 2005.

[4] SIMANČÍK, F. Potentiale der zellularen Metalle – Stärken/Schwächenprofil. Workshop Materials and Design, Leoben, 16. March 2005.

[5] SIMANČÍK, F. – BALOG, M. – NAGY, J.– IŽDINSKÝ, K. High strength profiles made by consolidation of Al-based melt-spun ribbons. Microsymposium on the nanocrystalline Al alloys, Varšava, 4. September 2005.

[6] SIMANČÍK, F. – BALOG, M. – NAGY, J. – IŽDINSKÝ, K. Nanostructured high strength aluminium profiles. Erich Schmid Kolloquium, Leoben, 15. March 2005.

[7] SIMANČÍK, F. – FLOREK, R. Reinforced aluminium foams – A promising solution for light-weight load-bearing components. METFOAM 2005, Kyoto, 21.-23. September 2005.

[8] LAPIN, J.: Development of cast gamma TiAl. How far are we from commercialization? Ecole des Mines de Nancy, LSG2M, Nancy, France, 10. July 2006.

[9] LAPIN, J.: From directionally solidified nickel-based superalloys to multiphase intermetallics. Ecole des Mines de Nancy, LSG2M, Nancy, France, 15. June 2006.

[10] SIMANČÍK, F. Kovové peny ako ľahký konštrukčný materiál. Seminár ÚTEF ČVUT, Praha, 31. October 2006.

[11] SIMANČÍK, F. PM foams. Design and Capabilities of PM Components and Materials, Grenoble, 24. June – 2. July 2006.

[12] JERZ, J. – SIMANČÍK, F. Aluminium Matrix Composites. *Suvremeni aluminijski materijali i proizvodi*. Šibenik, 18.–19. October 2003.

[13] ČAČKO, J. Development of cumulative damage in structure materials. *IX krajowa konferencja mechaniki pękania*. Kielce–Cedzyna, 14.–17. September 2003.

[14] SIMANČÍK, F. – JERZ, J. Aluminium Foams. *Suvremeni aluminijski materijali i proizvodi*. Šibenik, 18.–19. October 2003.

[15] SIMANČÍK, F. Factors influencing the development of advanced metallic materials. In *Advanced metallic materials 2003: proceedings of the international conference, Smolenice, 5.-7. November 2003.* Bratislava: IMMM SAS, 2003, s. 269 - 274.

[16] LAPIN, J. – NAZMY, M. Processing, microstructure and mechanical properties of directionally solidified TiAl based alloy reinforced by $Al_2O_3$ particles. *2003 TMS Annual Meeting and Exhibition.* San Diego, 2. – 6. March 2003.

[17] SIMANČÍK, F. Advanced metallic materials. *MATRIB´04: 9 conference on materials, processes, friction and wear, Vela Luka, 23.-25. June 2004.*

[18] JERZ, J. – SIMANČÍK, F. Ballistic performance of reinforced aluminium foam. *MATRIB´04: 9 conference on materials, processes, friction and wear, Vela Luka, 23-25 June 2004.*

[19] SIMANČÍK, F. Aluminium foams: dreams, reality and future. In *MetFoam 2003, Berlín, 23. – 25. June 2003.* Berlín: DFG, 2003, s. 1.

*[20]* SIMANČÍK, F. Platten und Schaumteile nach dem pulvermetallurgischen Verfahren: Herstellung, Eigenschaften und Anwendungen. *Metallschäume. Fortbildungsseminar DGM, Erlangen, 1.-2. April 2004.*

[21] SIMANČÍK, F. Presentation of applied reserach institutions and universities in middle east Europe. (Vyžiadaná prednáška.) *Applied Research for a New Europe. Forschung Austria Workshop, Alpbach, 25. August 2004.*

[22] SIMANČÍK, F. Recent advances in lightweight structural metals. (Abstrakt v zborníku a vyžiadaná prednáška.) In *Al-MAT´03 symposium, Bratislava, 4. – 6. June*

*[23]* DEGISCHER, H.P. - SIMANČÍK, F. Reinforcement of foamed aluminium and cellular metallic structures. *Syntactic and Composite Foams, Banff, 1.-5. August 2004.*

[24] SIMANČÍK, F. – FLOREK, R. Lightweight loadbearing components based on reinforced aluminium foams. In *Cellular metals and polymers, Fürth, 12-14. October 2004.* Fürth: Neue Materialien GmbH, 2004.

[25] SIMANČÍK, F. – ŠVEC, P. Fine-structured materials and their industrial applications. In *International conference advanced metallic materials and their joining, Bratislava, 27.-29. October 2004.* Bratislava: VÚZ PI SR, ÚMMS SAV, SNMTS.

### *ii. List of employees who served as members of the organising and/or programme committees for international conferences*

[1] Ing. Vladimír Oravský, CSc. – member of the Scientific committee of the International Symposium ISCORAMA-2, held in Gdansk (Poland), August 4.-8. 2003

[2] Dr. Ing. Jaroslav Jerz – member of the steering committee of the international conference Advanced Metallic Materials, held in Smolenice (Slovakia), November 5.-7. 2003

[3] RNDr. Pavel Šebo, DrSc. – member of the steering committee of the international conference Advanced Metallic Materials, held in Smolenice (Slovakia), November 5.-7. 2003

[4] Ing. Augustín Schweighoffer, CSc. – member of the steering committee of the international conference Advanced Metallic Materials, held in Smolenice (Slovakia), November 5.-7. 2003

[5] RNDr. Milina Zemánková – member of the steering committee of the international conference Advanced Metallic Materials, held in Smolenice (Slovakia), November 5.-7. 2003

[6] Ing. Vladimír Oravský, CSc. – member of the Scientific committee of IX. International Congress on Theory of Machines and Mechanisms, held in Liberec (Czech republic), Sept. 2004

[7] Dr. Ing. František Simančík - member of the programme committee of International Conference Advanced Metallic Materials and their Joining, held in Bratislava (Slovakia), October 25.-27. 2004

[8] Dr. Ing. Jaroslav Jerz - member of the programme committee of International Conference Advanced Metallic Materials and their Joining, held in Bratislava (Slovakia), October 25.-27. 2004

[9] Ing. Vladimír Giba, CSc. - member of the honorary committee of International Conference Advanced Metallic Materials and their Joining, held in Bratislava (Slovakia), October 25.-27. 2004

[10] Dr. Ing. František Simančík – member of the programme committee of International Congress on Powder metallurgy, held in Vienna (Austria), October 17.-21. 2004

[11] Ing. Juraj Stein, CSc. – member of the International Scientific Committee of "7th International Symposium Series on Measurement Technology and Intelligent Instruments held in Hudersfield, 2005

[12] Ing. Ivan Horváth, DrSc. – chairman of the steering committee of International Conference on Advanced Materials Micro and Nanotechnology – CAMIN 2005, held in Smolenice (Slovakia) April 27.–29. 2005

[13] Dr. Ing. František Simančík – member of the programme committee of the 9th international conference Technológia 2005, held in Bratislava, September 13.-14. 2005

[14] RNDr. Pavel Šebo, DrSc. – member of the programme committee of the 9th international conference Technológia 2005, held in Bratislava, September 13.-14. 2005

[15] Dr. Ing. František Simančík – chairman of the session on World Congress METFOAM 2005, held in Kyoto (Japan), September 21.-23. 2005

[16] Dr. Ing. František Simančík – member of the programme committee and chairman of the session of International Congress EURO PM 2005, held in Praha (Czech republic), October 2.-5. 2005

[17] Ing. Vladimír Giba, CSc. – member of the scientific committee of 13th international scientific conference COMAT-TECH 05 held in Trnava (Slovakia), October 20.-21. 2005

[18] Dr. Ing. František Simančík – co-coordinator of the international conference "Advances in Nanostructured Materials, Processing – Microstructure – Properties – NANOVED 2006 – NENAMAT" held in Stará Lesná (Slovakia), May 14.-17. 2006

[19] Ing. Martin Balog – member of the steering committee of the international conference "Advances in Nanostructured Materials, Processing – Microstructure – Properties – NANOVED 2006 – NENAMAT" held in Stará Lesná (Slovakia), May 14.-17. 2006

[20] Ing. Juraj Nagy – member of the steering committee of the international conference "Advances in Nanostructured Materials, Processing – Microstructure – Properties – NANOVED 2006 – NENAMAT" held in Stará Lesná (Slovakia), May 14.-17. 2006

[21] Dr. Ing. František Simančík – member of the programme committee MATRIB 2006 – Materials, Tribology, Processing, held in Vela Luka (Croatia), June 22.-24. 2006

[22] Dr. Ing. František Simančík – session chairman on the International conference ISMANAM 2006 – International Symposium on Metastable and Nanomaterials, held in Warsaw (Poland) August 28.-31. 2006

[23] Ing. Vladimír Giba, CSc. - member of the scientific committee of 14th international scientific conference COMAT-TECH 06 held in Trnava (Slovakia), October 19.-20. 2006

[24] Ing. Pavol Štefánik, PhD. – member of the steering committee of the 2nd international conference Segregation and Precipitation, held in Košice (Slovakia), October 26.-27. 2006

[25] Doc. Ing. Jozef Čačko, DrSc – member of the Scientific Advisory Board ECF-16 European Conference of Fracture – held in Greece, 2006

***iii. List of employees who served as members of important international scientific bodies (e.g. boards, committees, editorial boards of scientific journals)***

[1] Prof. Ing. Igor Ballo, DrSc. – member of the advisory board of the journal Inženýrská mechanika (Czech republic)

[2] Ing. Vladimír Oravský, CSc. - member of the advisory board of the journal Vibration Institute of India Journal (India)

[3] Doc. Ing. Jozef Čačko, DrSc. – member of the International Advisory Board, Centre of Excellence in Structural Integrity, TU Opole (Poland)

[4] Ing. Karol Iždinský, CSc. – member of the coordination board of NanoSci-ERA

[5] Ing. Vladimír Kliman, DrSc. – member of the European Structural Integrity Society

[6] Ing. Juraj Lapin, CSc. – expert of the EU commission for the evaluation of 6 FP

[7] RNDr. Pavel Šebo, DrSc. – national delegate in the EU COST programme 531: Lead free solders

[8] Doc. Ing. Jozef Čačko, DrSc. – member of the European Structural Integrity Society

[9] Ing. Vladimír Oravský, CSc. – member of the international IFToMM Commission A

[10] Ing. Vladimír Oravský, CSc. – member of the Vibration Institute of India

[11] RNDr. Erich Wiszt, CSc. – member of the Central European Associations for Computational Mechanics

[12] Ing. Juraj Stein, PhD. – member of the International Institute of Acoustics and Vibration, USA

[13] Dr. Ing. František Simančík – independent expert in the programme committee of 6 FP of EU Integrating and Strenhtening the ERA

[14] Ing. Oldrich Šlížek – member of the Central European Associations for Computational Mechanics

[15] Ing. Juraj Lapin, PhD. – member of the Minerals, Metals and Materials Society

***iv. List of international scientific awards and distinctions***

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## National position of the individual researchers

### *i. List of invited/keynote presentations at national conferences documented by an invitation letter or programme*

[1] SIMANČÍK, F. Recent advances in lightweight structural metals. Al-MAT'03 symposium, Bratislava, 4. – 6. jún 2003.

[2] ŠVEC, P. – SIMANČÍK, F. Fine-structured materials and their industrial applications. International conference advanced metallic materials and their joining, Bratislava, 27.-29. október 2004.

[3] IŽDINSKÝ, K. – CSUBA, A. – IŽDINSKÁ, Z. – JAŠ, M. Horčík a jeho zliatiny a ich uplatnenie v automobilovom priemysle. 9. medzinárodná konferencia Technológia 2005, Bratislava, 13.-14. september 2005.

[4] SIMANČÍK, F. New aluminium based materials for car body structures. 9. medzinárodná konferencia Technológia 2005, Bratislava, 13.-14. september 2005.

[5] IŽDINSKÝ, K. International Research Collaborations of Institute of Materials and Machine Mechanics. Conference Cooperation Potential of Slovak Research and Development Electrical Engineering and ICT, Bratislava, 24 October 2006.

### *ii. List of employees who served as members of organising and programme committees of national conferences*

[1] Ing. Pavol Štefánik, CSc. – member of the steering committee of the conference Konštrukčné materiály 2003, held in Bratislava, May 6$^{th}$, 2003

[2] Dr. Ing. František Simančík – member of the programme committee of the conference Nanoved 2004, held in Košice, September 13.-14. 2004

[3] Ing. Pavol Štefánik, CSc. – member of the steering committee of the conference Mechanical – destructive and metallographic testing of metals –EN and ISO standards, held in Bratislava, March 16$^{th}$ 2005

### *iii. List of employees serving in important national scientific bodies (e.g. boards, committees, editorial boards of scientific journals)*

[1] RNDr. Pavol Šebo, DrSc. – editor-in chief of the journal Kovové Materiály – Metallic Materials

[2] Ing. Vladimír Giba, CSc. – editor-in-chief of the journal Strojnícky časopis

[3] Ing. Vladimír Oravský, CSc. – member of editorial board of the journal Strojnícky časopis

[4] Ing. Jozef Murín, DrSc. – member of editorial board of the journal Strojnícky časopis

[5] Prof. Ing. Igor Ballo, DrSc. – member of editorial board of the journal Strojnícky časopis

[6] Ing. Juraj Stein, PhD. - member of editorial board of the journal Strojnícky časopis

[7] Ing. Vladimír Kliman, DrSc. - member of editorial board of the journal Strojnícky časopis

[8] Ing. Juraj Lapin, CSc. – editor-in chief of the journal Kovové Materiály – Metallic Materials

[9] Dr. Ing. František Simančík – member of editorial board of the journal Kovové Materiály – Metallic Materials

[10] RNDr. Ing. Stanislav Kúdela, CSc. – member of editorial board of the journal Kovové Materiály – Metallic Materials

[11] Dr. Ing. František Simančík – member of editorial board of the journal Powder Metallurgy Progress

[12] Dr. Ing. František Simančík – member of editorial board of the journal Zváranie - Svařování

[13] Ing. Vladimír Giba, CSc. – member of the editorial board of the journal Zvárač

[14] Ing. Pavol Štefánik – secretary of the committee of the Scientific society for metals

[15] Ing. Juraj Lapin, CSc. – member of the committee of the Scientific society for metals

[16] Ing. Vladimír Oravský, CSc. – member of the committee of the Slovak society for mechanics

[17] Dr. Ing. František Simančík – member of the committee of the Society for new materials and technologies

### *iv. List of national awards and distinctions*

[1] Presidency of the SAS awarded a commemorative plaque to Dr. Ing. František Simančík on the occasion of 50$^{th}$ anniversary of the establishment of Slovak Academy of Sciences (24. 6. 2003)

[2] Ing. Peter Múčka, PhD. won the third prize in the 2005 competition of young scientific workers of the Slovak Academy of Sciences

[3] Scientific council of Slovak Academy of Sciences awarded the **SAS 2006 annual price** to IMMM for the research of aluminium foam and for the development of its manufacturing

### *v. Supplementary information and/or comments documenting international and national status of the Organisation*

Institute's currently actively cooperates with following foreign organisations (only real cooperation including information and/or sample material exchange:

| **Universities:** | **Research centres:** | **Industry:** |
|---|---|---|
| Charles university Prague (CZ) | IFAM FhG Bremen + Dresden (D) | Alulight Ranshofen (A) |
| Inst. Nat. Polytech. Lorraine, (F) | EMPA Thun (CH) | SHW Wasseralfingen (D) |
| University of Cambridge (UK) | Škoda research Plzeň (CZ) | Gleich Kaltenkirchen (D) |
| Warsaw TU (PL) | DLR Bonn (D) | Eff Power Hisings Backa (S) |
| TU Vienna (A, 3 institutes) | ARCS Seibersdorf (A) | Metallwerk Plansee (A) |
| Uni Alicante (E) | IPP Max Planck Munich (D) | EADS Ottobrun (D) |
| TU + HMI Berlin (D) | FZ Jullich (D) | Siemens CT Munich (D) |
| EPFL Lausanne (CH) | CEIT San Sebastian (E) | |
| IRC - Univ. of Birmingham (UK) | IMM PAN Krakow (PL) | |
| | IPMS UAS Kiev (UA) | |
| | Inst. Of Thermomechanics AS CR, Prague (CZ) | |
| | Leibnitz Inst. for Solids and Mat. Research, Dresden (D) | |
| | Inst. of Struct. and Macrokinetics and Mat. Sci., Moskow (RUS) | |

## 4. Project structure, research grants and other funding resources

### International projects and funding

***i. List of major projects within the European Research Area – 5th and 6th Framework Programme of the EU, European Science Foundation, NATO, COST, INTAS, CERN, etc. (here and in items below please specify: type of project, title, grant number, duration, funding, responsible person in the Organisation and his/her status in the project, e.g. coordinator, principal investigator, investigator)***

**Project of the 5th FP of the EC:**

[1] Evaluation and Improvement of Suspension Seat Vibration Isolation Performance
Project No.: G3RD-2002-00827, Acronym: VIBSEAT
Principal investigator from IMMM SAS: Ing. J. Stein, PhD.
Coordinator: Prof. M. J. Griffin, Institute of Sound and Vibration Research, University of Southampton, United Kingdom,
Duration: 9/2002 - 11/2005, 10 partners from 6 European countries,
Funding: 64.000,- € / 3 years
1,120.348,- Sk from EU and 248.000,- from SAS (in 2003)
484.120,- Sk from EU and 719.000,- from SAS (in 2004)
302.938,- Sk from EU and 162.000,- from SAS (in 2005)

**Projects of the 6th FP of the EC:**

[2] New Materials for Extreme Environments
Integrated Project, 6th FP EC,
Priority 3 NMP FP6 2002 NMP-1, Project No.: IP 500253-1, Acronym: ExtreMat,
Principal investigator from IMMM SAS: Dr. Ing. F. Simančík
Coordinator: Prof. H. Bolt, Max-Planck-Institut für Plasmaphysik, Garching, Germany,
Duration: 12/2004 - 11/2008, 38 partners from 11 European countries,
Funding: 330.000,- € / 4 years.
253.000,- Sk (in 2004)
3,055.525,- Sk from EU and 771.000,- from SAS (in 2005)
3,978.000,- Sk from EU and 705.000,- from SAS (in 2006)
Dr. Ing. F. Simančík is coordinator of Subproject 2: “Novel heat-sink materials” (16 partners, funding: 5,000.000,- €)

[3] Intermetallic Materials Processing in Relation to Earth and Space Solidification
Integrated Project, 6th FP EC,
Priority 3 NMP FP6 2002 NMP-1, Project No.: IP 500635-2, Acronym: IMPRESS,
Principal investigator from IMMM SAS: Ing. J. Lapin, PhD.
Coordinator: Dr. D. J. Jarvis, European Space Agency, the Netherlands,
Duration: 11/2004 - 10/2009, 45 partners from 15 European countries,
Funding: 380.000,- € / 5 years.
309.000,- Sk (in 2004)
2,801.275,- Sk from EU and 942.000,- from SAS (in 2005)
3,383.000,- Sk from EU and 897.000,- from SAS (in 2006)
Ing. J. Lapin, PhD. is coordinator of WP 2a: “Fundamentals of solidification on earth and space” (6 partners, funding: 1,300.000,- €)

[4] Nanoscience in the European Research Area
Coordination Action of the 6th FP EC, Acronym: NanoSci-ERA
Principal investigator from IMMM SAS: Ing. K. Iždinský, PhD.
Coordinator: Dr. Izo Abram, CNRS, France,
Duration: 3/2005 - 2/2008, 15 partners from 11 European countries.

[5] European Lead-Free Soldering Network
Coordination Action of the 6th FP EC, Acronym: ELFNET
Project No.: NMP2-CT-2003-505504
Principal investigator from IMMM SAS: RNDr. P. Šebo, DrSc.
Coordinator: Dr. Jeremy Pearce, International Tin Research Institute, Hertfordshire, United Kingdom,
Duration: 5/2004 - 4/2007, 19 European countries.

**COST projects**

[6] Lead-free Solder Materials
Project No. 531.1, 51-98-9345-00/2002
Principal investigator from IMMM SAS: RNDr. P. Šebo, DrSc.
Coordinator: Prof. H. Ipser, University of Vienna, Austria,
Duration: 3/2002 - 3/2007, 43 partners,
Funding: 80.000,- Sk (in 2003).
110.000,- Sk (in 2004).
50.000,- Sk (in 2005).
100.000,- Sk (in 2006).

[7] Evolution and degradation of microstructure of CMSX4 superalloy during ageing and creep exposure
Project No. 538
Principal investigator from IMMM SAS: Ing. J. Lapin, PhD.
Coordinator: Dr. J. Oakey, School of Industrial and Manufacturing Science, Cranfield University, Cranfield, United Kingdom,
Duration: 1/2005 - 12/2008, 30 partners from 12 European countries,
Funding: 50.000,- Sk (in 2005).
100.000,- Sk (in 2006).

[8] Solidification behaviour and creep of gamma titanium aluminides
Project No. 522/29202, 51-98-9209-00/1999
Principal investigator from IMMM SAS: Ing. J. Lapin, PhD.
Coordinator: Dr. M. Nazmy, ABB Power Generation Ltd., Baden, Switzerland,
Duration: 1/1999 - 3/2003, 16 partners from 9 European countries.

### *ii. List of other international projects incl. funding*

[9] ALULIGHT-International, Ltd., Ranshofen, Austria
Development and optimisation of the precursor for the fabrication of aluminium foam
Principal investigator from IMMM SAS: Dr. Ing. F. Simančík
Duration: 1/1998 – long-term cooperation
Funding: 6,481.652,- Sk (in 2003)
3,011.000,- Sk (in 2004)
3,128.949,- Sk (in 2005)
3,372.335,- Sk (in 2006)

[10] CREATOR, Teknisk Utveckling AB, Vikmanshyttan, Sweden,
EFF – Power, Hisings Backa, Sweden
Development of the manufacturing of ceramic/lead composites by the melt infiltration process for the battery applications
Principal investigator from IMMM SAS: Mgr. S. Kúdela, PhD.
Duration: 1/2003 – 12/2003
Funding: 1,440.000,- Sk (in 2003)
4,068.000,- Sk (in 2004)
3,010.483,- Sk (in 2005)
4,637.120,- Sk (in 2006)

[11] GLEICH GmbH Metallplatten-Service, Kaltenkirchen, Germany
Development of structural components using of aluminium foam and investigation of their application possibilities
Principal investigator from IMMM SAS: Ing. Peter Tobolka
Duration: 2/2003 – long-term cooperation
Funding: 425.942,- Sk (in 2003)
872.000,- Sk (in 2004)
1,141.650,- Sk (in 2005)
511.088,- Sk (in 2006)

[12] Alulight Deutschland GmbH, Wasseralfingen, Germany
A pilot study on the possibility to model the properties of aluminium foam by finite element modeling
Principal investigator from IMMM SAS: Ing. T. Mazúch, PhD.
Duration: 5/2003 - 7/2003
Funding: 124.158,- Sk

[13] REMAG Recycling GmbH, Prambachkirchen, Austria
Recycling of magnesium scrap
Principal investigator from IMMM SAS: Dr. Ing. F. Simančík
Duration: 10/2000 - 9/2003
Funding: 164.644,- Sk (in 2003)

[14] Schwäbische Hüttenwerke SHW-AMT, Aalen-Wasseralfingen, Germany
Research and development of materials and components prepared by powder metallurgy
Principal investigator from IMMM SAS: Dr. Ing. F. Simančík
Duration: 4/2003 – long-term cooperation
Funding: 507.500,- Sk (in 2003)
1,079.000,- Sk (in 2004)
458.166,- Sk (in 2005)

[15] Škoda výzkum, Ltd., Plzeň, Czech republic
Research and development of service fatigue reliability evaluation methods of dynamically loaded structures
Principal investigator from IMMM SAS: Ing. Vladimír Kliman, DrSc.
Duration: 10/2004 – 12/2004
Funding: 252.000,- Sk (in 2004)

Further international applied research projects are particularly described in section 6. - Direct output to the society (applications of results).

### *iii. List of other important projects and collaborations without direct funding*

**Bilateral international projects (MAD)**

[17] Instytut Metalurgii i Inżynierii Materialowej im. Krupkowskiego, PAN, Krakow, Poland
High-temperature compression and creep deformation of multiphase intermetallic Ni-Al-Cr-Ti-X alloys
Principal investigator from IMMM SAS: Ing. J. Lapin, PhD.
Duration: 4/2000 – 12/2004

[18] Instytut Metalurgii i Inżynierii Materialowej im. Krupkowskiego, PAN, Krakow, Poland
Deformation and failure of the alumina short fibre reinforced MgLi matrix composites
Principal investigator from IMMM SAS: RNDr. Ing. S. Kúdela, PhD.
Duration: 1/2001 – 12/2003

[19] Instytut Metalurgii i Inżynierii Materialowej im. Krupkowskiego, PAN, Krakow, Poland

Investigation on nanocrystalline Mg-Li-Al alloys matrix composites reinforced with δ-$Al_2O_3$ ceramic fibers
Principal investigator from IMMM SAS: RNDr. Ing. S. Kúdela, PhD.
Duration: 1/2004 – 12/2006

[20] Institute for Problems of Materials Sciences UAS, Kiev, Ukraine
Behaviour and effective properties of mechanically and thermally loaded short fiber MMCs
Principal investigator from IMMM SAS: RNDr. Ing. S. Kúdela, PhD.
Duration: 1/2006 – 12/2008

[21] Eötvös Loránd University, Department of General Physics, Budapest, Hungary
Precipitation phenomena and work hardening in short-fiber reinforced MgLiAl matrix composites
Principal investigator from IMMM SAS: RNDr. Ing. S. Kúdela, PhD.
Duration: 1/2001 – 12/2006

[22] Institute of Mechanics BAS, Sofia, Bulgaria
Mechanics, Modelling and Development of New Composite Materials
Principal investigator from IMMM SAS: Ing. P. Štefánik, PhD.
Duration: 1/2001 – 12/2003

[23] Baotou Research Institute of Rare Earths, Baotou, China
R&D on RE elements and their industrial application
Principal investigator from IMMM SAS: Dr. Ing. F. Simančík
Duration: 12/2006 – 12/2003 – long-term cooperation

[24] The Institute of Thermomechanics AS CR, Prague, Czech republik
Interaction and feedbacks
Principal investigator from IMMM SAS: RNDr. E. Wiszt, PhD.

[25] Charles University in Prague, Faculty of Mathematics and Physics, Department of Condensed Matter Physics, Prague, Czech republic
Thermal properties of Mg-matrix composites reinforced with short fibres
Principal investigator from IMMM SAS: RNDr. Ing. S. Kúdela, PhD.

[26] Charles University in Prague, Faculty of Mathematics and Physics, Department of Physics of Materials, Prague, Czech republic
Deformation mechanisms of Mg-Li and Mg-Li-Al alloys matrix composites reinforced with short fibres
Principal investigator from IMMM SAS: RNDr. Ing. Stanislav Kúdela, PhD.

## National projects and funding

### *i. List of projects supported by the Agency for the Promotion of Research and Development (APVV/APVT), National Research Programmes, and their funding*

**Projects funded by Agency for Promotion of Reseach and Development:**

[1] Bulk nanostructured metallic materials for structural applications
(Project No.: APVT-51-021102)
Head of the project: Dr. Ing. F. Simančík
Duration: 1/2003 - 12/2005
Funding: 1,366.000,- (in 2003)
1,781.000,- (in 2004)

[2] Development of structural profiles from extruded powders of aluminium alloys with unique properties
(Project No.: APVT-51-031204)
Co-operation with: SAPA Profiles a.s., Žiar nad Hronom
VÚZ – PI SR (Welding Research Institute), Bratislava
Head of the project: Dr. Ing. F. Simančík
Duration: 1/2005 - 12/2007,
Funding: 1,665.000,- (in 2005)
2,125.000,- (in 2006), (including 800,000,- for VÚZ – PI SR)

[3] Gradient materials prepared by powder metallurgy from micro and nano powders
(Project No.: APVV-20-057805)
Head of the project: Doc. Ing. Štefan Emmer, PhD. - SjF STU Bratislava
Principal investigator from IMMM SAS: Dr. Ing. J. Kováčik
Duration: 5/2006 - 4/2009,
Funding: 152.000,- (in 2006)

[4] Modern network control systems for demanding industrial applications
(Project No.: APVV-99-045805)
Head of the project: Prof. Ing. Ján Murgaš, PhD. - SYPRIN, Ltd., Bratislava
Principal investigator from IMMM SAS: Ing. V. Giba, PhD.
Duration: 3/2006 - 2/2009,
Funding: 170.000,- (in 2006)

[5] Electron beam technologies with simultaneous preheat for joining of metallurgically dissimilar materials
(Project No.: APVV-20-P01305)
Head of the project: Doc. Ing. Štefan Emmer, PhD. - SjF STU Bratislava
Principal investigator from IMMM SAS: Ing. K. Iždinský, PhD.
Duration: 8/2005 - 7/2007,
Funding: 100.000,- (in 2005)
300.000,- (in 2006)

[6] Research of mechatronic systems and progressive technologies for surface material engineering
(Project No.: APVT-20-020904)
Head of the project: Prof. Ing. L. Jurišica, PhD. - FEI STU Bratislava
Principal investigator from IMMM SAS: Ing. K. Iždinský, PhD.
Duration: 1/2005 - 12/2007,
Funding: 200.000,- (in 2005)
250.000,- (in 2006)

**Projects funded by European Social Fund**

[7] Creation of network for innovations, research & development in the field of advanced materials and technologies of their joining (MATNET)
(No.: JPD 3 2005/1-018)
Head of the project: Dr. Ing. J. Jerz
Duration: 4/2006 - 3/2008
Funding: 6,833.700,- Sk / 2 years
845.964,- Sk (in 2006)

[8] Establishment of the workstation for further education oriented to transfer of knowledge on modern materials, technologies and designing into industrial practice
(No.: JPD 3 2004/4-084)
Head of the project: Doc. Ing. J. Čačko, DrSc.
Duration: 9/2005 - 8/2008
Funding: 4,150.000,- Sk / 3 years
322.000,- Sk (in 2005)
883.682,- Sk (in 2006)

**Centre of the Excellence - Slovak Academy of Sciences**

[9] Centre for nanostructural materials (NANOSMART)
Head of the project: Doc. RNDr. J. Dusza, DrSc. - IMR SAV, Košice
Principal investigator from IMMM SAS: RNDr. Ing. S. Kúdela, PhD.
Duration: 10/2002 - 9/2006
Funding: 135.000,- Sk (in 2003)
135.000,- Sk (in 2004)
108.000,- Sk (in 2005)
130.000,- Sk (in 2005)

**Projects of the Governmental Program for R&D**

[10] New materials in submicrometre technology
(No.: ŠO 51/03R0600/03R0603)
Head of the project: Prof. RNDr. P. Šajgalík, DrSc. - IIC SAV, Bratislava
Principal investigator from IMMM SAS: Dr. Ing. F. Simančík
Duration: 9/2003 - 12/2005
Funding: 634.435,- Sk (in 2003)
552.371,- Sk (in 2004)
553.709,- Sk (in 2005)

[11] The further education of creative industrial personnel
(No.: 2003 SP 51/028 09 00/028 09 11)
Head of the project: Prof. Ing. Štefan Medvecký, PhD., SjF ŽU
Principal investigator from IMMM SAS: Ing. J. Košút, PhD.
Duration: 9/2003 - 12/2005
Funding: 1,354.000,- Sk (in 2004)
1,412.976,- Sk (in 2005)

**R&D projects supported co-operation of SAS with Slovak industrial companies**

[12] Increase of the added value of engineering products by application of advanced materials and technologies
Principal investigator from IMMM SAS: Ing. Juraj Lapin, PhD.
Co-operation with: Letecké motory, joint–stock company, Považská Bystrica
Elektrokarbon, joint–stock company, Topoľčany
Duration: 7/2002 - 6/2003,
Funding: 460.000, - Sk.

[13] Modelling power flows paths in buildings
Principal investigator from IMMM SAS: RNDr. Erich Wiszt, PhD.
Co-operation with: OSBD Martin
Duration: 7/2002 - 6/2003,
Funding: 300.000, - Sk.

[14] Use of Al foam to reduce the transfer of impact stress between ceramic plates
(Project funded by United States Army Research Laboratory - European Research Office)
Principal investigator from IMMM SAS: Dr. Ing. J. Jerz
Co-operation with: ZTS-Matec, joint-stock company, Dubnica nad Váhom
Military Technical and Testing Institute Zahorie, Malacky
Duration: 10/2003 - 7/2004,
Funding: 386.891, - Sk.

***ii. Number of projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding***

| VEGA | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| **number** | 8 | 7 | 8 | 9 |
| **funding (millions of SKK)** | 0,437 | 0,573 | 0,605 | 0,800 |

## Summary of funding from external resources

| External resources | 2003 | 2004 | 2005 | 2006 | total | average |
|---|---|---|---|---|---|---|
| **external resources (millions of SKK)** | 17,187 | 20,282 | 24,968 | 29,603 | 92,040 | 23,010 |
| **external resources transfered to coooperating research organisations (millions of SKK)** | 0,870 | 0,841 | 0,450 | 0,800 | 2,961 | 0,740 |
| **ratio between external resources and total salary budget** | 1,041 | 1,213 | 1,526 | 1,630 | - | 1,353 |
| **overall expenditures from external as well as institutional resources(millions of SKK)** | 41,793 | 47,421 | 51,220 | 55,876 | 196,310 | 49,078 |

***Supplementary information and/or comments on research projects and funding resources***

Institute is subsidised organisation, which has to cover some of its expenses by own finances gained from external sources. Currently the external resources incl. national public grants cover ~ 53% of annual budget. The current structure of external sources involves ~25% EU projects, ~40 % international industrial projects, ~15% national industrial projects, ~15% national public grants and 5% other sources.
In the assessed period the external resources (excl. national public grants) increased from 15,153 to 20,486 mil.SKK (~35%), whereas the institutional funding increased only of 16.8%.

## 5. Organisation of PhD studies, other pedagogical activities

### *i. List of accredited programmes of doctoral studies (as stipulated in the previously effective legislation as well as in the recently amended Act on the Universities)*

According to the previously effective legislation, Institute was an educational institution in two scientific fields:

1. 39-01-9 Applied mechanics, specialization: mechanics of rigid and non-rigid bodies
2. 39-03-9 Material engineering and threshold state of materials.

In Institute, a board for defence of higher-doctorate dissertations resided. Its head was doc. Ing. Štefan Markuš, DrSc., former employee of IMSAS.

In 2005, Institute has been accredited as an external educational institution participating in implementation both, full-time and part-time forms of the study programmes:

1. Technical materials, study field 5.2.26 Materials (in cooperation with MtF STU Bratislava, residing in Trnava)
2. Applied mechanics, study field 5.1.7 Applied mechanics (in cooperation with SjF STU in Bratislava)

### *ii. Summary table on doctoral studies (number of internal/external PhD students; number of students who completed their study by a successful thesis defence; number of PhD students who quitted the programme)*

| PhD study | 31.12.2003 | | | 31.12.2004 | | | 31.12.2005 | | | 31.12.2006 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| number of potential PhD supervisors | 15 | | | 16 | | | 16 | | | 16 | | |
| PhD students | number | defended thesis | students quitted | number | defended thesis | students quitted | number | defended thesis | students quitted | number | defended thesis | students quitted |
| internal | 8 | 1 | 4 | 8 | 2 | 0 | 2 | 0 | 6 | 3 | 2 | 2 |
| external | 2 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 1 | 3 | 0 | 0 |
| supervised at external institution by the research employees of the assessed organisation | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |

**Note:** From 12 internal students that have quitted PhD study 6 already defended their disertations (2 disertations were defended on 1.3.2007) and 3 others are still working at Institute. Only 3 students quitted PhD study without intention to finish it.

### *iii. Postdoctoral positions supported by*

#### *a) external funding (specify the source)*

The Institute is permanently looking for financial sources to stabilize the PhD students after finishing their studies. The philosophy is based on the tendency to attract them to work predominantly on the projects bringing extra-budgetary sources. This scheme has been applied for following postdoctoral students supported by indicated external projects:

Roman Florek – Alulight -International GmbH, Ranshofen, Austria „Development of aluminium foam“
Martin Nosko - Alulight -International GmbH, Ranshofen, Austria „Development of aluminium foam“
Martin Balog – APVT-51-031204 „Development of structural profiles from extruded powders of aluminium alloys with unique properties”
Adrian Csuba – New Materials for Extreme Environments (ExtrMat) IP 6 EU FP , APVT-20-020904 „Research of mechatronic systems and progressive technologies for surface material engineering“

***b) internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz***

***iv. Summary table on pedagogical activities in undergraduate programmes for each year***

| Teaching | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| **lectures (hours/year)** | **216** | **219** | **213** | **242** |
| **practicum courses (hours/year)** | **119** | **119** | **119** | **143** |
| **supervised diploma works (in total)** | **2** | **1** | **2** | **5** |
| **members in PhD committees (in total)** | **2** | **1** | **0** | **5** |
| **members in DrSc. committees (in total)** | **1** | **1** | **1** | **2** |
| **members in university/faculty councils (in total)** | **2** | **2** | **2** | **2** |
| **members in habilitation/inauguration committees (in total)** | **1** | **0** | **2** | **0** |

***v. List of published university textbooks***

[1] JERZ, J. Výroba a průmyslové využití pěnového hliníku. In MICHNA, Š. – LUKÁČ, I. – OČENÁŠEK, V. – KOŘENÝ, R. – DRÁPALA, J. – SCHNEIDER, H. – MIŠKUFOVÁ, A. a kol. *Encyklopedie hliníku.* Děčín: Alcan Děčín Extrusions s.r.o., 2005. 700 s. ISBN 80-89041-88-4. s. 642-653. (kap. 10.8.)

***vi. Number of published academic course books***

-

***vii. List of joint research laboratories/facilities with the universities***

At the moment there is formal joint research laboratory with university. However intense mutual cooperation between many Slovak universities and IMMM SAS still exists, mainly in the field of materials engineering, transfer of modern technologies into the industrial praxis and novel approaches for application of advanced materials for the purpose of structural design of various industrial products. Because of the exceptionally large amount of experiences in abovementioned topics there is a clear and continuously increasing effort from Slovak universities to start and establish common working compartments with IMMM SAS. The founding of common laboratory in the field of development of new materials and technologies with the Faculty of Materials Technogy of the Slovak University of Technolgy in Trnava has been already agreed.

Similar activity is in progress with the Faculty of Mathematics, Physics and Informatics of the Comenius University in Bratislava. Both partners are currently active in the development of ultrahard thin coatings via the physical vapour deposition technique.

### *viii. Supplementary information and/or comments on doctoral studies and pedagogical activities*

Besides our own PhD students, also doctoral students from abroad are welcome to perform some of their work at the IMMM SAS. Jens Vierke – from the Hahn Meitner Institute, Berlin; Gregorz Cieslak – from the Warsaw University of Technology and Zohrev Razavihesabi – from the Sharif University of Technology, Teheran, Iran visited the Institue in 2006 in order to use the technique for the preparation of nanostructured materials for completion of their PhD thesis.
Seminars predominantly oriented towards PhD students are weekly organized. The thematic scope covers the fields of materials engineering, modern technologies and novel application techniques of advanced materials in machinery products. The seminars with large space for discussions are attended not only by doctoral students but also by other young scientific workers.
According to current legislation on postdoctoral studies the SAS has lost the possibilty of educating their own PhD students. It is practically impossible to engage new doctoral students in other terms than at the beginning of the new school year when the entrance exams are organized by the Faculty. However at this time the majority of all graduated students is already employed and thus not available for doctoral studies. Moreover the legal status of University PhD students on external education institutions (SAS) is not clear and rather discriminating. Therefore it is very difficult to gain young graduated people for PhD studies. Another problem is to gain a foreign student outside the EU, that have to pay large scholarships to the University what makes them their studies quite expensive. We register large interest from these countries but the current obstacles are hardly to overcome. With respect to these difficulties we regard the employment of three new doctoral students in the last year as a big success. However all three applied for Materials Engineering and none for Applied Mechanics.
IMMM strongly supports the attendance of PhD students on international conferences. The students are encouraged to present their work for national and international public and their efforts are financially supported. 59 attendances (including 33 in abroad) were recorded in the assessed period of time.
In order to support the interest of graduated students from Universities to continue in doctoral study, our institute decided to participate on project supported by Slovak state program of R&D „Education of special oriented doctoral students for difficult design and development problems“ (more details concerning this project are given in chapter 4. “Project structure - National projects” or at the project web site: http://www.phd.sav.sk/).
It has been stated that solution of serious problems concerning the background of doctoral study requires fundamental changes. Such changes can be expected in frame of knowledge society formation, only. An abovementioned project web site “Doctoral study and direction of Slovakia to knowledge society” is one of outputs of the project. The aim of this web site is contribution to creation and strengthening of synergic bonds between the doctoral study, research and industrial area in conditions of knowledge based economy formation in Slovakia.

The web site provides for:

- basic information on the doctoral study and the knowledge society formation in Slovakia and situation in this field abroad, as well,
- presentation of doctoral students from the whole Slovakia (whose need was indicated by the inquiry),
- list of R&D enterprises in Slovakia,
- studies in doctoral study and knowledge society fields,

- long-term survey to monitor doctoral study problems and efficiency,
- discussion forums on topics concerning the doctoral studies and knowledge society (proposed new elements in doctoral study are subject of the survey and discussions, as well)
- job opportunities for PhD graduates and another useful services.

The further educational activities were developed within the frame of the project supported by European Social Fund „Creation of the workplace of further education with a view to a transfer of knowledge with modern materials, technology and machine design into industrial practice“. The main objective is to establish the center, that organize courses not only for developers and design engineers, but also for university teachers, scientific workers and doctoral students. The aim of these courses is to teach design engineers from industry the new complex principles for designing of machine components and constructions using proper material selection with regard to functionality, service loading and product costs and simultaneously to optimize the component design and to find the appropriate technology of its production in large series. At the education, modern software Cambridge Engineering Selector (CES) is applied. It belongs to the most recognized educational tools in this field at renowned world universities. IMSAS is the only proprietor of multi-licence for this educational product in Slovakia. During the courses, the participants have an opportunity to work on one's own with real databases containing properties of nearly all current materials, as well as modern technologies parameters and to learn the use of these databases for structural design focused on various industrial applications.
Further activity was the preparation of three step educational courses „Cambridge Engineering Selector aided design“. The completely new modern videoconference classroom equipped with 10 PC has been built in 2006 mainly for the purpose of educational courses based on new approaches to materials education using „Cambridge Engineering Selector - Aided Design“.

Additional education activities of IMMM SAS were directed towards:

- the further education of creative industrial personnel,
- creation of the workplace of further education with a view to a transfer of knowledge with modern materials, technology and machine design into industrial practice (project supported by European social fund)
- creation of network for transfer of knowledge, innovations, research & development in the field of advanced materials and technologies (MATNET) (project supported by European social fund)

## 6. Direct output to the society
**(applications of results, popularisation and outreach activities)**

### *i.* List of the most important applications resulted from research projects (more information can be found on the Institute's web site)

**Applications that already reached serial production level:**

[1] Stator of camshaft phaser for automotive engine BMW (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria and SAPA Profles, joint-stock company, Žiar nad Hronom, Slovakia - annual production ~850.000 pcs).

[2] New types of sliding contacts prepared by gas pressure infiltration of graphite with copper (developed in cooperation with Elektrokarbon, joint–stock company, Topoľčany, Slovakia - annual production ~10.000 pcs)

[3] Aluminium foam stiffeners for side rail of Ferrari Modena car (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria - annual production ~8.000 pcs).

[4] Deformation part for AUDI Q7 which is used for enhancement of passenger's safety. The aluminium foam insert is placed into the grid which separates luggage space from the passenger cabin and its main purpose is to absorb luggage impact energy in the case of accident. (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria - annual production ~200.000 pcs).

[5] Solution of wear resistant cylinder renovation for textile machines – installation of new technologies (cooperation with Kordservice SK, a. s., Senica, Slovakia).

[6] Coating technology for glass dental basin with Ti (cooperation with CHIRANA DENTAL, Ltd., Piešťany, Slovakia).

[7] Foam expansion tester for research of foamable precursor properties. The device is capable of whole process recording, measurement of expansion behaviour, foam collapse, expansion rate and temperatures during foaming process at various heating modes, fully numerically controlled. Device is manufactured directly by IMSAS. Already 8 devices were sold to several research institutes (TU Vienna, HMI-Berlin, TU-Zagreb, IFAM-Bremen).

**Applications at prototype / testing level:**

[8] Metal/ceramic composite for battery anodes produced by hot pressure infiltration (developed in cooperation with EFF – Power, Hisings Backa, Vikmanshyttan, Sweden)

[9] Composite material with extremely high thermal conductivity used as heat-sink material for electronic devices (developed within the frame of 6th FP project ExtreMat – for Plansee Reutte, Austria)

[10] Lead-free solders for joining of metal matrix composite materials (developed within the frame COST 531.1 project)

[11] Device for large scale production of reinforced aluminium foam panels. These unique incombustible panels are already being applied in combination with special composites for the purpose of shock wave protection during explosions of ammunition under the military vehicles (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria)

[12] Aluminium foam oil pan, which is applied for the purpose of noise damping of combustion engine (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria).

[13] Ultra lightweight WiFi-box of aluminium foam with enhanced electromagnetic field shielding ability applied for signal transmitter of wireless internet (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria).

[14] Lightweight folding table of aluminium foam for railway carriage with excellent thermal stability - 50% weight reduction in comparison wit recently produced bakelite tables. (developed in cooperation with Borcad Ltd. CR)

[15] Lightweight crash box for trucks with effective absorption of deformation energy in case of impact of personal vehicle into the rear part of truck or trailer. Crash box is part of the construction protected against so called “under-run” of personal vehicle under truck. (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria)

[16] Damping part for Z axis of machine tool made of aluminium foam applied for the purpose of attenuation of Z axis shaft vibrations induced during machining process. (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria)

[17] Deformation component for street lamp filled with the aluminium foam enhancing of passengers passive safety, reducing of G force and at the same time maintaining of bending strength and ability to absorb deformation energy during vehicle impact into the street lamp. (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria)

[18] Damping aluminium foam insert for chain wheel of combustion engine applied for the purpose of vibration and noise reduction. (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria)

[19] Aluminium foam stiffener for bicycle handle bar which allow not only to reduce the weight by partial reinforcing of critically loaded cross-sections, but also to enhance the stiffness of the handle bar and passive safety of bikers. (developed in cooperation with ALULIGHT-International, Ltd., Ranshofen, Austria)

[20] Design and fabrication of gauging fixture (cooperation with Bruel-Kjaer, Ltd., Slovakia).

[21] Design and fabrication of special technological tool (cooperation with Slovtech Trade, Ltd., Bratislava, Slovakia).

[22] Design and fabrication of special structural components (cooperation with Bapex, Ltd., Bratislava, Slovakia).

### *ii.* List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign organisations

[1] In 2003 and 2004 Dr. Simančík participated in elaboration of “Prognosis of science and technology development and use by 2015” in the frame of the governmental Project 2003SP51/0280700/0280701 as member of new materials and technology group.

[2] In 2003 Dr. Lapin, Dr. Iždinský and Dr. Giba elaborated prognostic questionnaires in the frame of governmental project 2003SP51/0280700/0280701 “Prognosis of science and technology development and use by 2015”

[3] In 2005 Dr. Giba worked as member of Accreditation Commission in the field of mechanical engineering.

[4] In 2003 - 2004 six institute's workers and in 2005 – 2006 five ones worked as experts for governmental organizations.

### *iii.* List of the most important popularisation activities

[1] In 2003 the Institute organized public doors open day together with a meeting devoted to 50th anniversary of its foundation. It was a part of International Conference Advanced Metallic Materials 2003, held on 5-7 November, 2003.

[2] On 7 November 2005 and 13 November 2006 doors open days with presentations were organized in the frame of European Science Week, with special invitation of students.

[3] Journals and newspapers publications informing on institute's scientific activities:
2004: 7 (Das Ősterreichische Industriemagazin, Zváranie – Svařování, Hospodárske noviny, Trend, Formát, Večerník)
2005: 2 (Pravda, SME)
2006: 12 (Quark, Pravda, Trend, Zváranie–Svařování, Hospodárske noviny, Správy SAV)

[4] Participation in exhibitions:
2004: 4 (Aluminiummesse 2004, Essen; Euromold 2004, Frankfurt am Main; PM World Congress 2004 Vienna; Cellular metals and Polymers, Fürth)

[5] Presentations:
2005: 1 (press conference)
2006: 2 (conference "Cooperation Potential of Slovak Research and Development Electrical Engineering and ICT", students seminar at the Faculty of Materials and Technology STU Trnava)

[6] TV presentations:
26 October 2005, life, in special program of TA3 TV station

[7] Radio presentations:
3 and 9 November 2005 - Slovak Radio International
19 January 2006 - Slovak Radio International and 22 June 2006 Rádio Slovensko

***iv.* List of patents issued abroad, incl. revenues**

See chapter II.1.vi.

***v.* List of the patents issued in Slovakia, incl. revenues**

See chapter II.1.vi.

***vi.* List of licences sold abroad, incl. revenues**

There are no licenses sold abroad. However contractual agreements exist with industrial partners, which allow them to use institute's patents under special conditions (e.g. long term research projects, lump sum monthly financing the research, etc.)

***vii.* List of licences sold in Slovakia, incl. revenues**

-

***viii.* List of selected small size contracts with national industrial partners, incl. revenues**

[1] CHIRANA DENTAL, Ltd., Piešťany
Development of the coating technology for glass dental basin with Ti
Revenues: 29.700,- Sk/2004, 99.880,- Sk/2005, 69.200 ,- Sk/2006

[2] OSBD, Martin
Statistical evaluation of technical measures on the heat consumption in houses & consultation dealing with specific exploitation of computer networks
Revenues: 83.890,- Sk/2003, 70.000,- Sk/2004

[3] Martico, Ltd., Martin
Solution of data-set security
Revenues: 269.400,- Sk/2003, 28.400,- Sk/2004

[4] KIWA, Ltd., Nitra
Determination of the structure of electronic components
Revenues: 47.150,- Sk/2003, 55.200,- Sk/2004, 22.600,- Sk/2005

[5] Prvá zváračská, joint–stock company, Bratislava
Characterization of the structure of brazed and welded joints
Revenues: 76.395,- Sk/2003, 165.740,- Sk/2004

[6] VÚZ – PI, Bratislava
Determination of physical properties of welded joints
Revenues: 15.500,- Sk/2003,13.000,- Sk/2006

[7] IBOK, joint–stock company, Bratislava
Fractographic analysis of structural components
Revenues: 41.500,- Sk/2003, 92.270,- Sk/2004

[8] VUSTAM, joint–stock company, Považská Bystrica
Failure analysis of the speedway motor-cycle
Revenues: 10.000,- Sk/2003, 40.600,- Sk/2005

[9] Drôtovňa KORDY, joint –stock company, Hlohovec
Determination of reasons responsible for the failures of coated wires
Revenues: 10.000,- Sk/2003

[10] Magna Slovteca, Ltd., Nové Mesto nad Váhom
Analysis of spring wires
Revenues: 24.050,- Sk/2003

[11] Slovenský hodváb, joint–stock company, Senica
Renovation of textile machine components – installation of new technologies
Revenues: 25.60,- Sk/2003

[12] Brüel- Kjaer, Ltd., Bratislava
Design and fabrication of gauging fixture
Revenues: 48.860,- Sk/2003

[13] Slovtech Trade, Ltd., Bratislava
Design and fabrication of special technological tools
Revenues: 100.200,- Sk/2003,13.800,- Sk/2004

[14] Bapex, Ltd., Bratislava
Design and fabrication of special structural components
Revenues: 16.800,- Sk/2006

[15] Miba Slovakia, Ltd., Dolný Kubín,
Measurement of thermal conductivity of sintered steels
Revenues: 10.000,- Sk/2004

[16] Kinex, joint–stock company, Bytča,
Assessment of the failure of the water pump bearing
Revenues: 37.000,- Sk/2004

[17] MKTS, Ltd., Sečovce
Solution of data-set security
Revenues: 61.800,- Sk/2004, 51.800,- Sk/2005

### *ix. List of larger research projects with industrial partners, incl. revenues*

[1] ALULIGHT-International, Ltd., Ranshofen, Austria
Development and optimisation of the foaming raw-material for production of aluminium foam
Revenues: 6,481.652,- Sk/2003, 3,011.000,- Sk/2004, 3,128.949,- Sk/2005, 3,372.335,- Sk/2006

[2] EFF – Power, Hisings Backa (CREATOR), Vikmanshyttan, Sweden
Development of the manufacturing of ceramic/lead composites by the melt infiltration process for the battery applications
Revenues: 1,440.000,- Sk/2003, 4,068.000,- Sk/2004, 3,010.483 ,- Sk/2005, 4,637.120,- Sk/2006

[3] GLEICH, Ltd., Metallplatten-Service, Kaltenkirchen, Germany
Development of structural components using of aluminium foam and investigation of their application possibilities
Revenues: 425.942,- Sk/2003, 872.000,- Sk/2004, 1,141.650 ,- Sk/2005, 511.088,- Sk/2006

[4] Schwäbische Hüttenwerke SHW-AMT, Aalen-Wasseralfingen, Germany
Research and development of materials and components prepared by powder metallurgy
Revenues: 507.500,- Sk/2003, 1,079.000 ,- Sk/2004, 458.166,- Sk/2005

[5] Elektrokarbon, joint–stock company, Topoľčany & Aircraft engines, joint–stock company, Považská Bystrica
Increase of the added value of engineering products by application of advanced materials and technologies
Revenues: 460.000,- Sk/2003

[6] Elektrokarbon, joint–stock company, Topoľčany
Impregnation of carbon-graphite preforms with copper and copper alloy
Revenues: 366.800,- Sk/2004, 453.760,- Sk/2005, 729.780,- Sk/2006

[7] Kordservice SK, joint–stock company, Senica, (Slovkord, Ltd.)
Solution of wear resistant cylinder renovation for textile machines
Revenues: 278. 910,- Sk/2003, 198.270,- Sk/2004, 286.670,- Sk/2005, 360.750,- Sk/2006

[8] Alulight Deutschland, Ltd., Wasseralfingen, Germany
A pilot study on the possibility to model the properties of aluminium foam by finite element modeling
Revenues: 124.158,- Sk/2003

[9] REMAG Recycling, Ltd., Prambachkirchen, Austria
Recycling of magnesium scrap
Revenues: 164.644,- Sk/2003

[10] OSBD, Martin
Modelling power flow paths in buildings
Revenues: 300.000,- Sk/2003

[11] ZTS-MATEC, joint–stock company, Dubnica nad Váhom & Military institute of technology and testing Záhorie, Malacky
Using Al foam to reduce the transfer of impact stress between ceramic plates
Revenues: 386.891,- Sk/2004

[12] Škoda výzkum, Ltd., Plzeň, Czech republic
Assessment of fatigue life and reliability of a drivetrain system. Research and development of service fatigue reliability evaluation methods of dynamically loaded structures
Revenues: 252.000,- Sk/2004

[13] University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Croatia
Development of the expandometer for investigation of foaming process
Revenues: 358.224,- Sk/2005

[14] Fraunhofer Gesellschaft, Institut für Fertigungstechnik und Angewandte Materialforschung, Bremen, Germany
Development of the expandometer for investigation of faoming process
Revenues: 380.303,- Sk/2006

[15] Elektrokarbon, joint –stock company, Topoľčany
Development of the technological equipment for pressure infiltration of graphite sliding contacts
Revenues:1,452.000 ,- Sk/2006

[16] SAPA Profily, joint –stock company, Žiar nad Hronom
Development of the manufacturing technology for stator of camshaft phaser for automotive engine & development of furnace for powdered ingots heating
Revenues: 980.000,-Sk/2006

### *x. Summary* of outreach activities

| Outreach activities | 2003 | 2004 | 2005 | 2006 | total |
|---|---|---|---|---|---|
| **studies for the decision sphere, government and NGOs, international and foreign organisations** | 2 | 0 | 0 | 0 | 2 |
| **articles in press media/internet popularising results of science, in particular those achieved by the Organization** | 0 | 7 | 2 | 12 | 21 |
| **appearances in telecommunication media popularising results of science, in particular those achieved by the Organization** | 0 | 0 | 3 | 2 | 5 |
| **public popularisation lectures** | 1 | 0 | 2 | 3 | 6 |

### *xi. Supplementary* information and/or comments on applications and popularisation activities

## 7. Background and management. Staffing policy and implementation of findings from previous assessments

### i. *Summary table of personnel*

| Personnel | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| **all personel** | 77 | 77 | 81 | 84 |
| **research employees from Tab. Research staff** | 37 | 36 | 41 | 45 |
| **FTE from Tab. Research staff** | 34,4 | 35,5 | 37,7 | 39,7 |
| **averaged age of research employees with university degree** | 44,26 | 44,92 | 44,5 | 44,68 |

### ii. *Professional qualification structure*

| Number of | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| **DrSc.** | **4** | **3** | **3** | **3** |
| **PhD / CSc.** | **19** | **19** | **18** | **18** |
| **Prof.** | **0** | **0** | **0** | **0** |
| **Doc./Assoc. Prof.** | **1** | **1** | **1** | **1** |

### iii. *Status and development of research infrastructure incl. experimental, computing and technical base (description of the present infrastructure, premises, and material and technical resources. Infrastructure, instrumentation and major technical equipment necessary for the achievement of the objectives specified in the research Concept*)

| | | 2003 | 2004 | 2005 | 2006 | Total |
|---|---|---|---|---|---|---|
| investments in mil. SKK | Institutional funding | 0,323 | 0,182 | 2,474 | 0 | 2,979 |
| | External sources | 6,704 | 1,946 | 2,204 | 8,876 | 19,73 |
| | Building reconstruction | 0,051 | 0,194 | 0,387 | 4,083 | 4,715 |
| | Equipment incl. Computer technique | 6,977 | 1,934 | 4,291 | 4,793 | 17,995 |
| Expenses in mil.SKK | Institutional funding | 26,641 | 30,483 | 30,734 | 31,130 | 118,988 |
| | External sources | 15,153 | 16,936 | 20,486 | 24,745 | 77,32 |

In spite of very low institutional support for investment - 2,979 mil. SKK, which is ~1.5% from the total budget, satisfactory development of external resources made possible to invest 22,709 mil. SKK, which is ~11.6 % from the total budget in assessed period.

Significant improvements of the Institute´s infrastructure were accomplished. It is to be stressed out that all the reconstruction and up-dating activities were financed from own financial sources gained exclusively by the research activitites.
In the main building on Racianska st, all sanitary facilities were completely reconstructed, new dressing-rooms were built, the damaged roof was repaired, all halls and corridors were new painted.
In the experimental hall on Patrónka cca. 400 $m^2$ were totally reconstructed including the exchange of electrical distribution plants and building of new sanitary facilities. Generally

37 new plastic windows and 5 thermally insulated large scale gates were built-in. A new security system has been installed.
The Institute´s branch in Martin was connected to the academic optical net SANET. Due to optical connection the branch has gained new potential for co-operations mostly using the VRVS system for video-conference communications. All institute's employees are equipped with modern PC including necessary software.

Main laboratory equipment which was purchased in assessed period is:
tensile tester ZWICK - 3.087,- thousand SKK
furnace for foaming– 1.018 thousand SKK (2003)
software for tester ZWICK – 705,-thousand SKK {2004),
Dilatometer LINSEIS – 2.070,- thousand SKK
microscope OLYMPUS – 1.196,- thousand SKK
creep extensometers INSTRON – 510,- thousand SKK
backscattered electron detector KVANT – 377,- thousand SKK.

Institute takes a part in consortium Multidisc, which comprises 5 institutes of SAS with an aim to share costs for purchase expensive characterisation equipment. In this way X-ray diffractometer BRUKER was purchased in 2005-2006.

IMSAS possesses all necessary equipment for the proposed research, although some of the devices especially for structural characterisation of materials are of old generation.
In case of sufficient investment costs (e.g. from European funds), purchase of better characterisation equipment is intended, in particular high resolution TEM, nanoindenter, and various analytical devices.
The most interesting (sometime unique) Institute's equipment consists of:

***technological facilities:***
- 4 autoclaves for pressure infiltration
- furnace for foaming of panels
- equipment for injection molding of metallic foam
- foam expandometer
- vacuum press for hot diffusion bonding
- cold isostatic pressing (CIP) max. pressure 400 MPa.
- hot isostatic pressing (HIP) max. pressure 200 MPa, max. temperature 1800*C
- plasma spraying of metallic and ceramic coatings on flat and round surface
- continuous electroless or galvanic coating of carbon fibres with metals Cu, Ni, etc.
- PVD magnetron
- furnace for unidirectional solidification
- extrusion and ECAP hydraulic presses

**Structure characterisation equipment:**
-metallography equipment
-electron microscopy (TEM and SEM - Jeol):
-energy dispersive X-ray analysis
-high speed ion milling machine (Balzers)
-light optical microscopy (Olympus)
-dilatometry, DTA, DSC, TG (Linseis, Netsch)
-mass spectrometry

**materials testing equipment:**
- testing of mechanical properties (tensile, compressive, bending tests) (Zwick, Instron)
- static creep tests, thermomechanical testing
- fatigue tests (hydropulsator MTS, EDYZ)
- abrasive wear testing
- thermal conductivity measurement
- vibration and noise measurement and analysis

**iv.** ***Status and development of bibliographic resources, activities of the Organisation's library*** **and/or information centre**

Both Institute's library and information centre in Bratislava and library in the Institute's branch in Martin offer – apart from standard loan service from own holdings – possibility of interlibrary and international interlibrary loans. They ensure journals subscription and monographs and other literary sources acquisition, journal circulation service; provide information on new publications and offers of publishing houses, scientific information retrieval on request and copy service. The library keeps registration databases of scientific publications and citations of Institute's workers and prepares bibliographies or citations compilations for project and other reports. At the same time, the publications are registered in ARL system.

The Institute's workers have electronic access to variety of full text and other scientific databases as the Institute participates in a number of consortia by means of Central Library SAS and thanks to the fact every workplace has appropriate hardware equipment.

Library holdings status and development:

2003 13 236 items
2004 13 304 items
2005 13 551 items
2006 13 781 items

Number of subscribed scientific journals was 35, 34, 34 and 32, resp.

**v.** ***Describe how the results and suggestions of the previous assessment were taken into account***

In the previous assessment (2004) Institute was evaluated with high A degree gaining 93 points from 100.

Following suggestions were given by the Assessment commission:

- Improve equipment and computer infrastructure
  18 mil SKK were invested in equipment and computer technique

- increase number of finished doctoral students
  5 internal students defended their dissertations in assessed period
  further 2 internal + 1 external students submitted their dissertations in 2006 - all were already successfully defended on 1.3.2007 (i.e. 8 students already successfully finished), 1 dissertation was submitted in February 2007
  Only 3 students quitted PhD study in assessed period without intention to finish it

- increase qualification of senior scientists – DrSc.- level
  V.Kliman and P.Šebo achieved this level in assessed period
  J.Lapin submitted his DrSc work in 2006 and successfully defended on 31.1.2007

**vi.** ***Supplementary information and/or comments on management, research infrastructure, and trends in personnel development***

The development of the Institute is closely related to the ability of gaining external financial sources. Although the potential is extremely high, current system of law sets limitations to further development. IMMM is a subsidised organization that cannot earn more than 50 % of its overall budget. However, according to the results achieved in 2006, the income from external sources was already at the level of 48 %. It means that the external income cannot practically be further increased. As the increase of the institutional contribution from the state is expected to be no more than approximately 3 % in the next year, the Institute´s development of 8 % achieved in average within last 4 years can most probably not be prolonged in the near future. This will negatively affect the salaries that have been growing by 8 % in last years. The difference between salaries in Slovak Academy of Sciences and other economic sectors (growing typically by 6-7 % yearly) will grow. It will finally more and more intensify the brain-drain what is especially sensitive for IMSAS. Our young research workers predominantly oriented to mechanical

engineering and machinery have very attractive offers from the increasing industry that cannot be competed with our sources. Solving this problem is one of the top priorities that will substantially determine the future of the science not only at IMMM SAS.

**Other information relevant to the assessment**