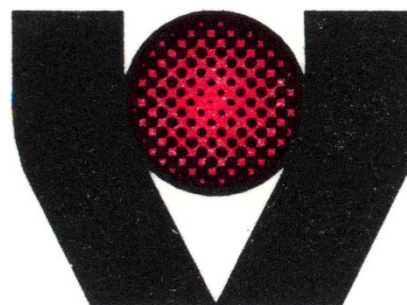


Institute of Materials Research SAS



Košice, 9 November 2016

Institute of Materials Research SAS



Mission

The Institute was established in 1955 as the Laboratory of Engineering and Metallurgical Technologies of the Technical University in Košice. In 1970 it was incorporated into the Slovak Academy of Sciences as the Institute of Experimental Metallurgy. This name was changed to the Institute of Materials Research of the Slovak Academy of Sciences (IMR SAS) in 1992.

The main tasks of the Institute in basic and applied research include development and testing of new materials and technologies, education and training of PhD and undergraduate students (Materials Science and Materials Engineering) and development new testing/characterization methods and standards.

Expertise

- ❖ Advanced metallic materials (steels, non-ferrous materials, advanced alloys)
- ❖ Powder metallurgy (ferrous, non-ferrous, nanomaterials)
- ❖ Structural and functional ceramics
- ❖ Biomaterials, polymers, and hybrid materials

Management

Director	RNDr. Pavol Hvizdoš, CSc. (since 06/2014) RNDr. Peter Ševc, PhD (till 05/2014)
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Deputy director	RNDr. Ján Mihalik
Science secretary	Ing. Karel Saksl, DrSc.

Head of Scientific Board	Prof. Dr. Ján Dusza (till 05/2013) Dr. Pavol Hvizdoš (06/2013 – 06/2014) Ing. Ľubomír Medvecký, PhD. (since 06/2014)
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Environment - Organization

Science Departments

1. Dept. of Microstructure and mechanical properties of steels
2. Dept. of Microstructural engineering of steels
3. Dept. of Diffusion and transformation processes in metallic systems
4. Dept. of Ferrous powder metallurgy
5. Dept. of Nanostructured materials
6. Dept. of Electroceramics
7. Dept. of Structural ceramics

Laboratory Departments

1. Dept. of Microstructural and chemical analyses
2. Dept. of Technology and design / mechanical workshop
3. Dept. of Mechanical testing
4. Dept. of Informatics, computer science and applied mathematics

*2015 - established: Project support unit
Brokerage unit*

Since 01/01/2016 new Organizational statute – 3 science divisions + 2 support units

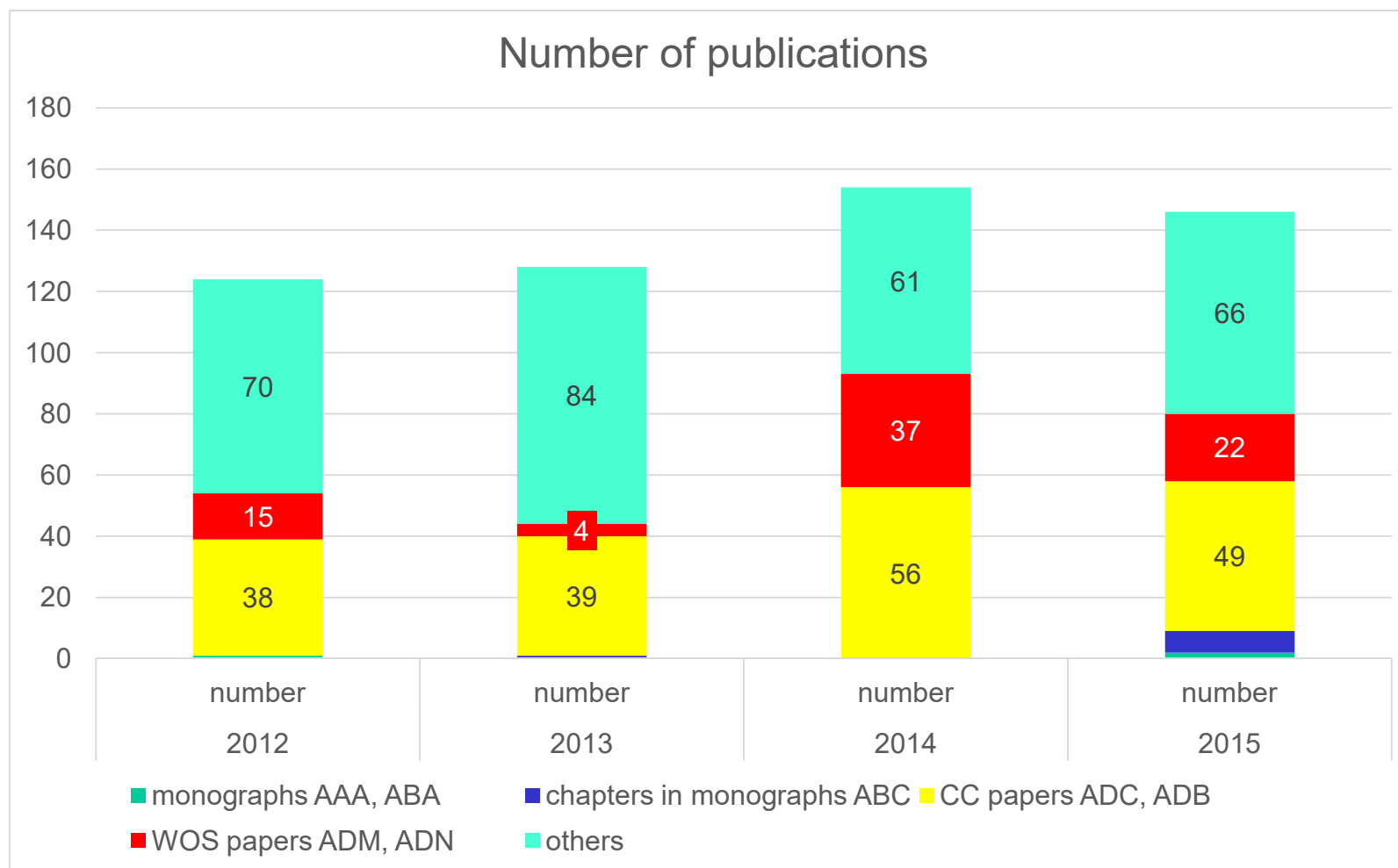
Environment - Personnel

Personnel	2012	2013	2014	2015
All personnel	82	86	88	80
Research staff	57	61	63	57
Researchers FTE	50,09	49,79	51,51	48,71
PhD students	13	13	15	14
PhD FTE	10,32	11	12,32	12,24
Average age of Researchers	47,1	45,2	46,5	46,3

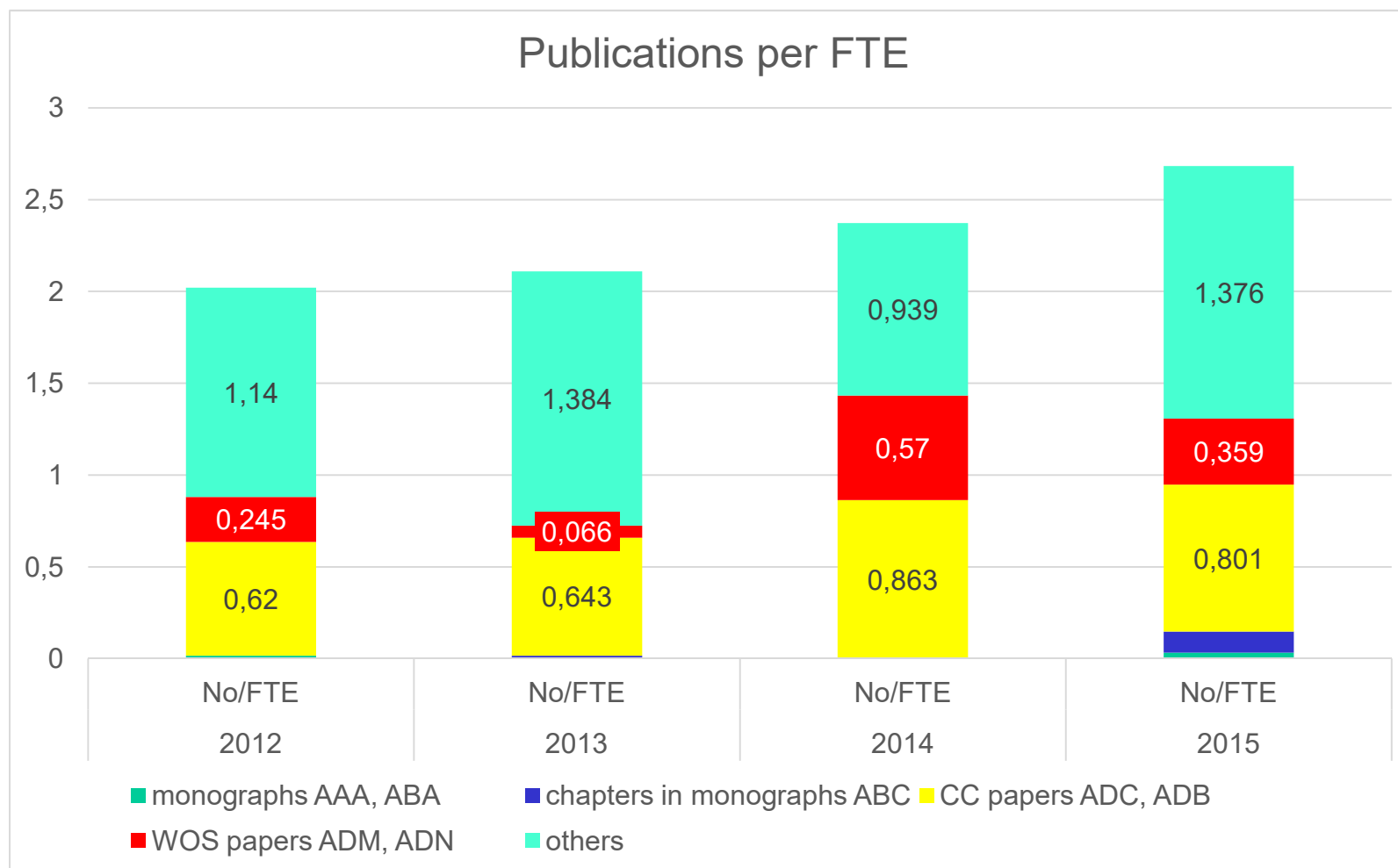
Environment - Personnel

Age and gender	2012	2013	2014	2015
Males	29	31	32	29
Females	28	30	31	28
Young researchers <35, males	4	6	6	5
Young researchers <35, females	6	8	5	2

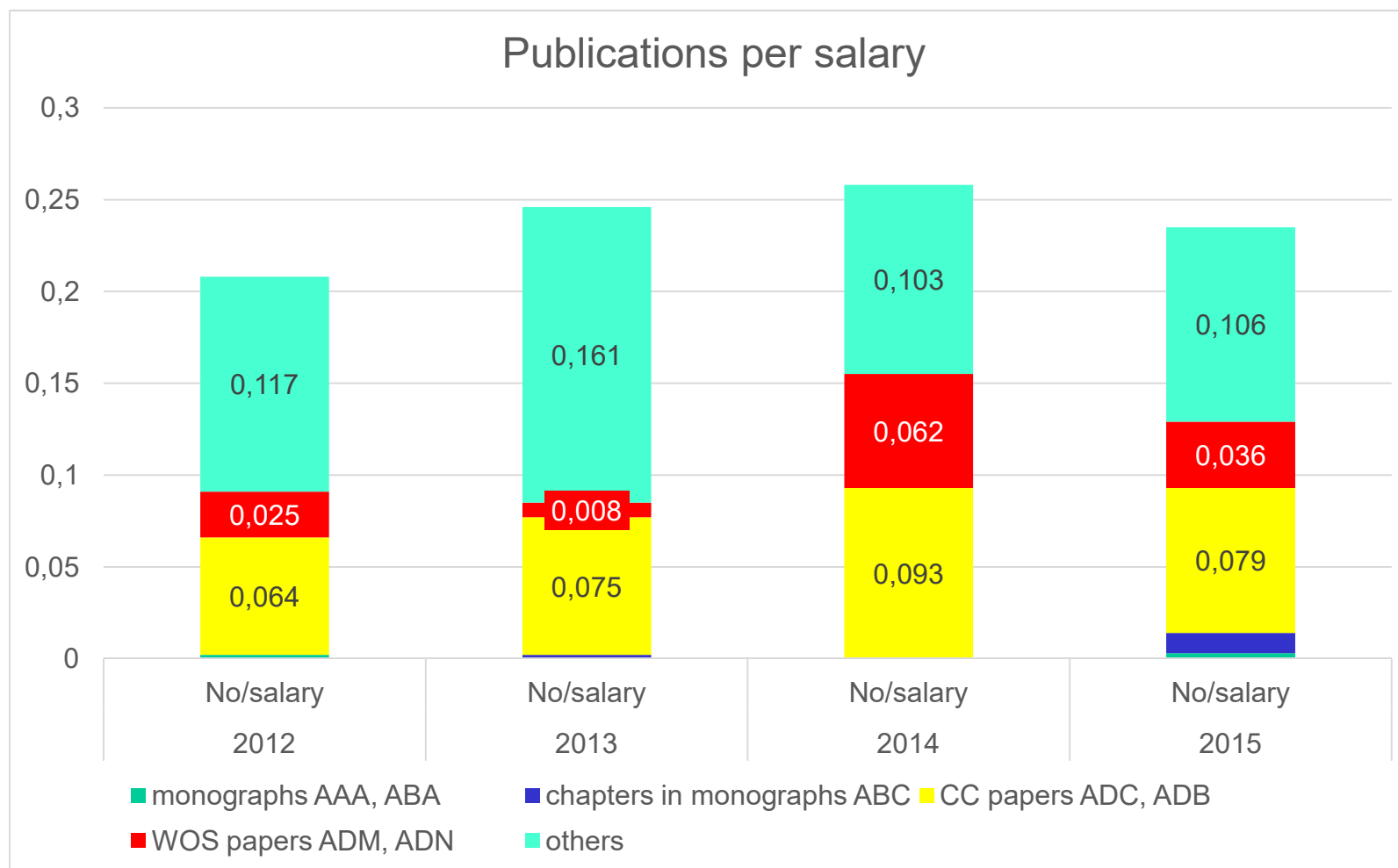
Scientific outputs



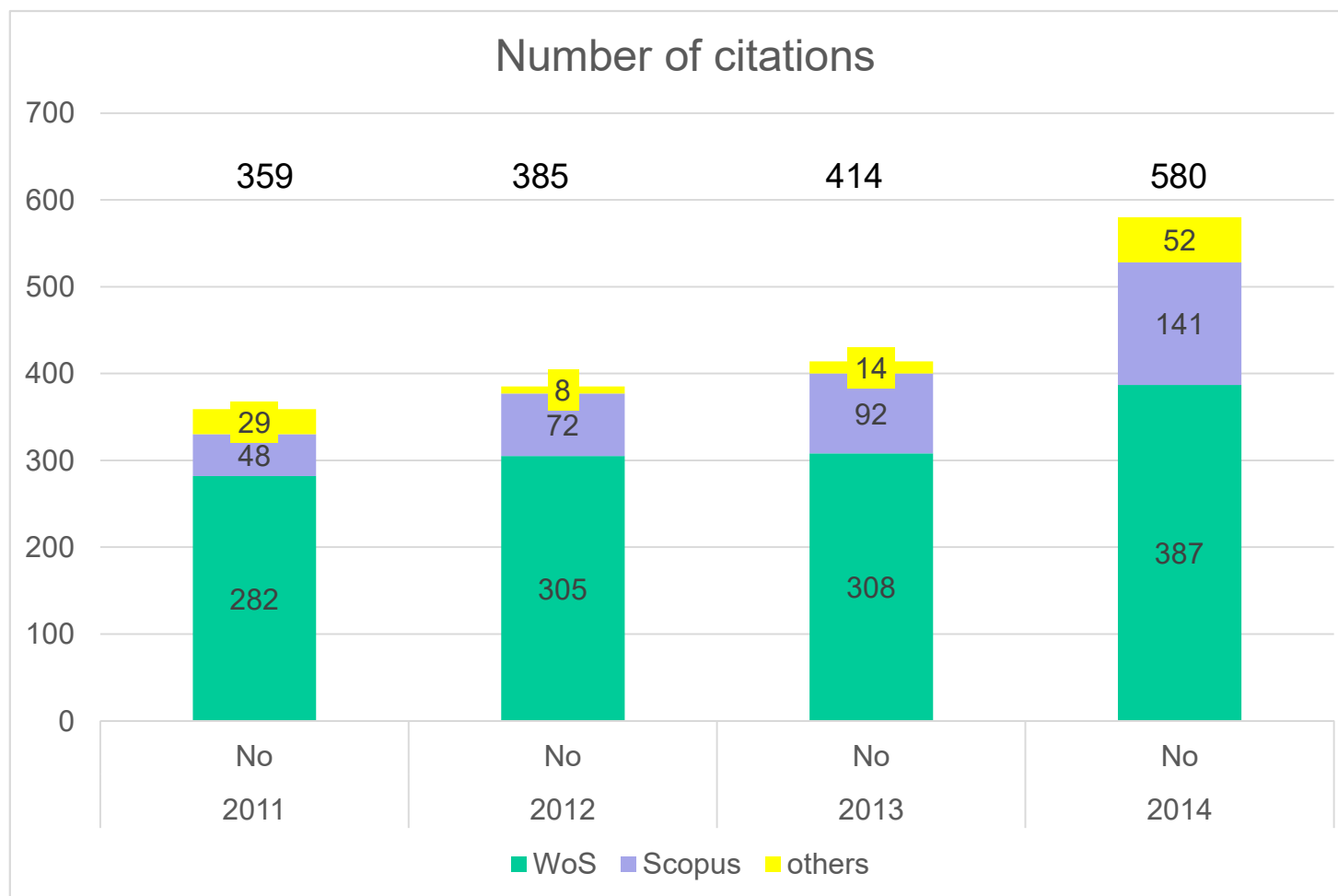
Scientific outputs



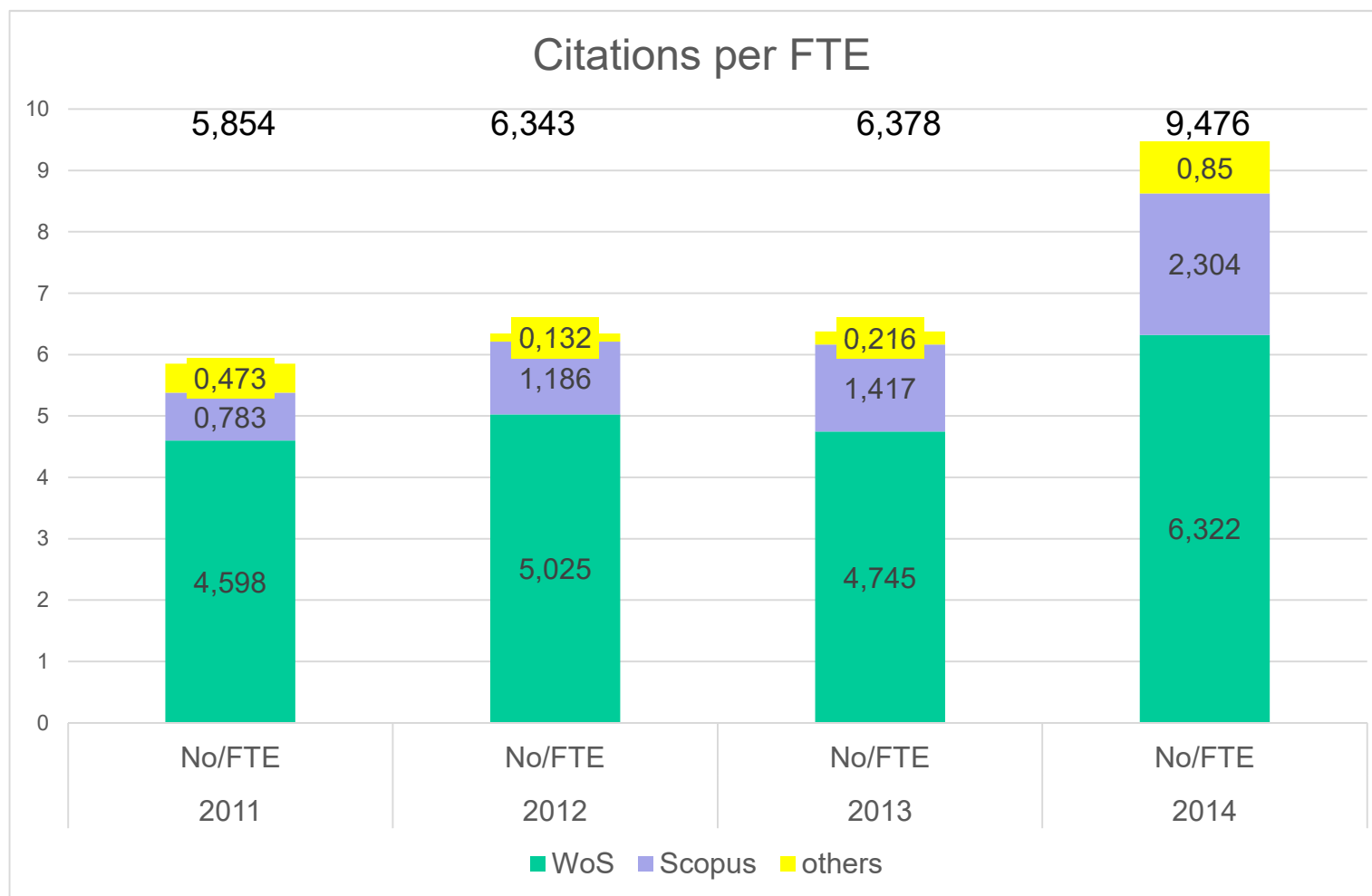
Scientific outputs



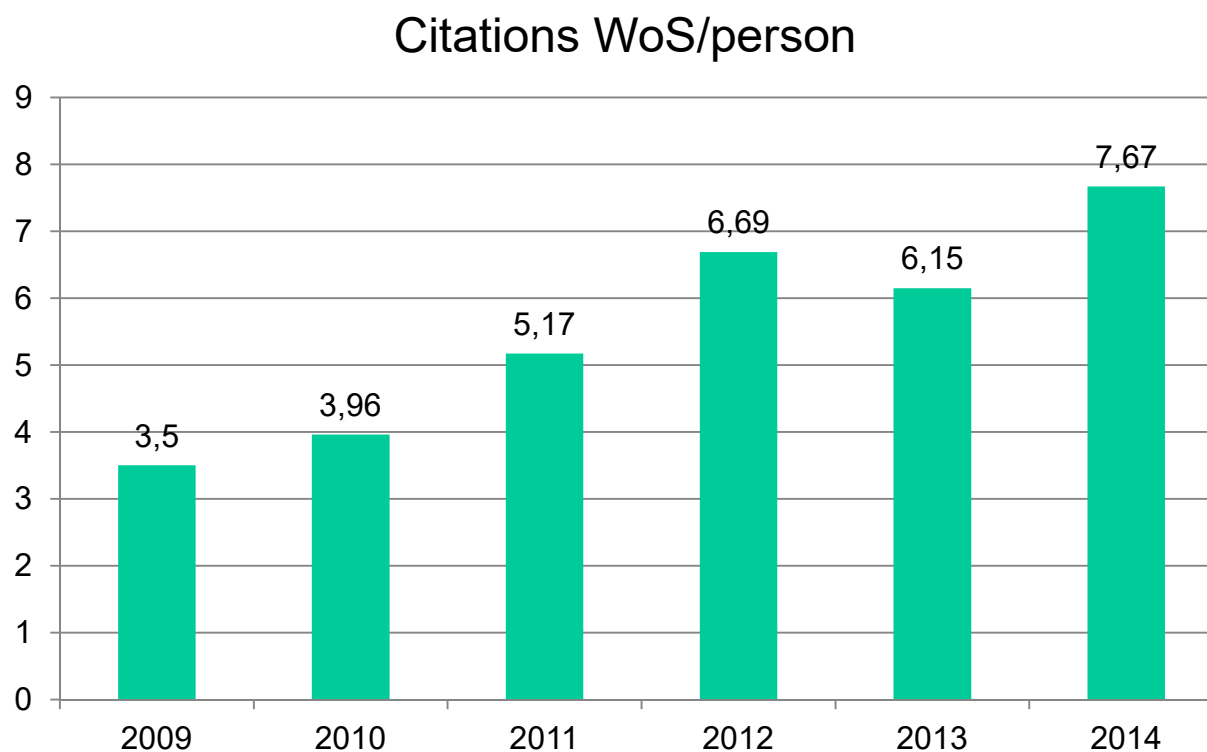
Scientific outputs



Scientific outputs



Scientific outputs



Patents

Inventions for which a patent was issued

PV number: 288155

Authors: Ferdinandy Milan, Dusza Ján, Lofaj František, Hegedúsová Lucia, Kottfer Daniel Doc. Ing. PhD.

Title: Zariadenie na prípravu vrstiev karbidov, nitridov, silicidov, boridov W, Cr, Mo, Re, Os, Rh, Ru a multivrstvových a kompozitných štruktúr na vnútornej valcovej ploche elektricky vodivej rúry

PV number: 288254

Authors: Ferdinandy Milan, Dusza Ján, Lofaj František, Kottfer Daniel, Doc. Ing. PhD.

Title: Zariadenie na vytváranie ochranných vrstiev na vnútorných plochách rotačných telies odparovaním látky elektrickým lúčom

PV number: 288322

Authors: Kováč František, Petryshynets Ivan, Stoyka Vladimír, Škorvánek Ivan, prof. Ing. Kvačkaj Tibor, CSc.

Title: Spôsob výroby izotrópných elektrotechnických ocelí s nízkymi wattovými stratami

Owner / co-owner: Ústav

Reported inventions

PV number: PP 00049-2012;

Author: Medvecký Ľubomír

Title: Spôsob prípravy prekursorovej zmesi kalcium fosfátových cementov

PV number: PP 00091-2012

Authors: Kováč František, Petryshynets Ivan

Title: Zrnovo orientovaná elektrotechnická oceľ mikrolegovaná vanádom a spôsob jej výroby

PV number: PP 00095-2013

Authors: Bureš Radovan, Strečková Magdaléna, Fáberová Mária, Kollár Peter, Fúzer Ján

Title: Spôsob prípravy magnetických kompozitov s polymérnym elektroizolačným spojivom

PV number: PP00089-2014

Authors: Medvecký Ľubomír, Giretová Mária, Eva Petrovová

Title: Biopolymérny kompozitný systém na regeneráciu chrupavky

PV number: SK 288278 B6

The names of authors: Ferdinandy Milan, Dusza Ján, Lofaj František, Kottfer Daniel

Title: Spôsob a zariadenie na povrchovú úpravu vnútorných plôch rotačných telies

PV number: PP 00090-2015

Authors: Kováč František, Petryshynets Ivan

Title: Vysokopevná izotrópna elektrotechnická oceľ s kompozitnou mikroštruktúrou

Publishing

Publisher

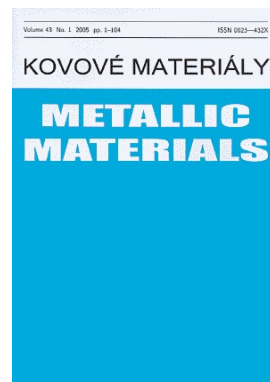
Powder Metallurgy Progress



Since 1.1.2016 – DeGruyter Open

Co-publisher

**Kovové materiály/Metallic
Materials (CC)**



**Acta Metallurgica Slovaca
(Scopus)**



+ 10 conference Proceedings

Institute in international context

Major Projects

Project	type	period	Funding (eur)	role
KMM-VIN	FP7	2012-2015	26 348	Partner
MAMINA	FP7	2008-2012	149 350	WP leader
ISWA	FP7	2011-2013	15 780	Partner
IntegRisk	FP7	2008-2012	12 922	WP leader
Hoganas	Hoganas Chair V	2011-2014	98 376	WP leader
GRACE	M-ERA.NET	2014-2017	24 033	WP leader
ExploGuard	M-ERA.NET	2014-2017	33 333	WP leader
LightMat	M-ERA.NET RusPlus	2015-2016		WP leader

9 other projects – international exchanges and bilateral agreements

Institute in international context

International conferences/workshops organized by IMR SAS

2012

Fraktografia 2012

E-MRS Fall Meeting – Symposium Nanoceramics (co-organizer)

2013

Functional Composite Materials

Fractography of Advanced Ceramics

2014

Functional Composite Materials

Deformation and Fracture in Structural PM Materials

Local Mechanical Properties 2014

2015

Functional Composite Materials

Workshop Fractography of Sintered Materials

Fraktografia 2015

Institute in international context

Long term international collaborations

- Founding member of the KMM-VIN (European Virtual Institute on Knowledge-based Multifunctional Materials AISBL)
- Queen Mary University, London, UK
- Chalmers University, Gothenburg, Sweden
- DESY, Hamburg, Germany
- Hoganas, Hoganas, Sweden (sponsored 4 PhD students)
- Eotvos Lorand Technical University, Budapest, Hungary
- Bruker Co., (sponsored 1 PhD student)
- Technical University, Vienna, Austria (conferences, journal)
- Brno Technical University, Brno, Czech Republic
- Mining Technical University, Ostrava, Czech Republic
- Polytechnic University, Warsaw, Poland
- AGH Krakow, Poland
- Polytechnic University, Tallin, Estonia
- ...

Institute in national context

National Projects

APVV	2012	2013	2014	2015
Number	9	1	-	8
Role	6C+3W	C	-	5C+3W
Funding	159 300	209 377	174 076	199 448

C – coordinator, W – work package leader

VEGA	2012	2013	2014	2015
Number	17	17	18	20
Funding	112 147	122 226	106 822	135 458

Institute in national context

Long term strategic partnership with academic institutions

- Technical University, Košice
- P.J. Šafárik University, Košice
- Institute of Experimental Physics SAS, Košice
- Institute of Geotechnics SAS, Košice
- Institute of Inorganic Chemistry, SAS Bratislava

- A. Dubček University, Trenčín
- Slovak Technical University, Trnava/Bratislava

Strategic partnership with government/business/industry partners

- Membership in regional cluster IT+R (automation and robotics)
- Collaboration with cluster eFusion (energy industry)
- Membership in National technological platform for raw materials (NTP VVIS)

Contracts and research projects with industry

	2012	2013	2014	2015
Number	20	34	52	43
Revenues	17 405	83 851	43 534	50 635

Collaboration with national/regional industrial/business partners:

- Mops Press, s.r.o. Snina
- US Steel, Košice
- SEZ Krompachy, a.s
- Embraco Slovakia, s.r.o. Spišská Nová Ves
- Spinea, s.r.o. Prešov
- ALCAST, a.s. Snina
- Regada, s.r.o. Prešov
- Magneti Marelli PWT Slovakia, s.r.o. Bratislava
- Tesla Stropkov, a.s., Stropkov
- Miba Sinter Slovakia, s.r.o. Dolný Kubín
- ŽP, a.s. Podbrezová
- ZVS HOLDING, a.s. Dubnica nad Váhom
- ...

External resources - EU Structural Funds

Year	Project title	Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute
2012	Advanced technology of preparation of micro-composite materials for electrotechnics	26220220105	12/2010-03/2015	389180	C
	New Materials and Technology for energetics	26220220061	09/2010-08/2013	282350	W
	Infrastructure Improving of Centre of Excellence of Advanced Materials with Nano - and Submicron - structure	26220120035	5/2010-4/2013	291326	C
	Centre of Excellence of Ceramics, Glasses and Silicates	26220120056	9/2010-08/2013	229843	W
	Slovak Research-Innovation Platform on Sustainable Mineral Resources	26220220053	01/2010-06/2013	25218	W
	Research Centrum for Combined and Renewable Resources of Energy	26220220064	06/2010-12/2013	39951	W
	Technology of preparation of electrical steels possessing high permeability for high affectivity electromotors	26220220037	01/2010-06/2012	19503	C
	Zvýšenie kvality	261102301054	01/2012-12/2012	342484	C
	Center of excellence of biomedical technologies	26220120066	11/2010-10/2013	70425	W
	Advanced implants seeded with stem cells for hard tissue regeneration and reconstruction	26220220032	01/2010-03/2012	61797	C
2013	Research centre of Advanced Materials and Technologies for Recent and Future Applications "PROM A TECH"	26220220186	08/2013-07/2015	448246	W

Overall EUSF funding

**3.5 million EUR
to IMR**

+

**~4,89 million EUR
disponible
infrastructure**

Infrastructure development



EUSF



Research centre of advanced materials and technologies “PROMATECH”

Prof. RNDr. Ján Dusza, DrSc.

30.8.2013 – 31.12.2015

ITMS 26220220186

Coordinator: SAS

Partners – IMR, IEP, IGt, IMMM, UPJŠ, TUKE

41 new labs (25 in new building)

over 80 new equipment

IMR SAS – 12 new labs

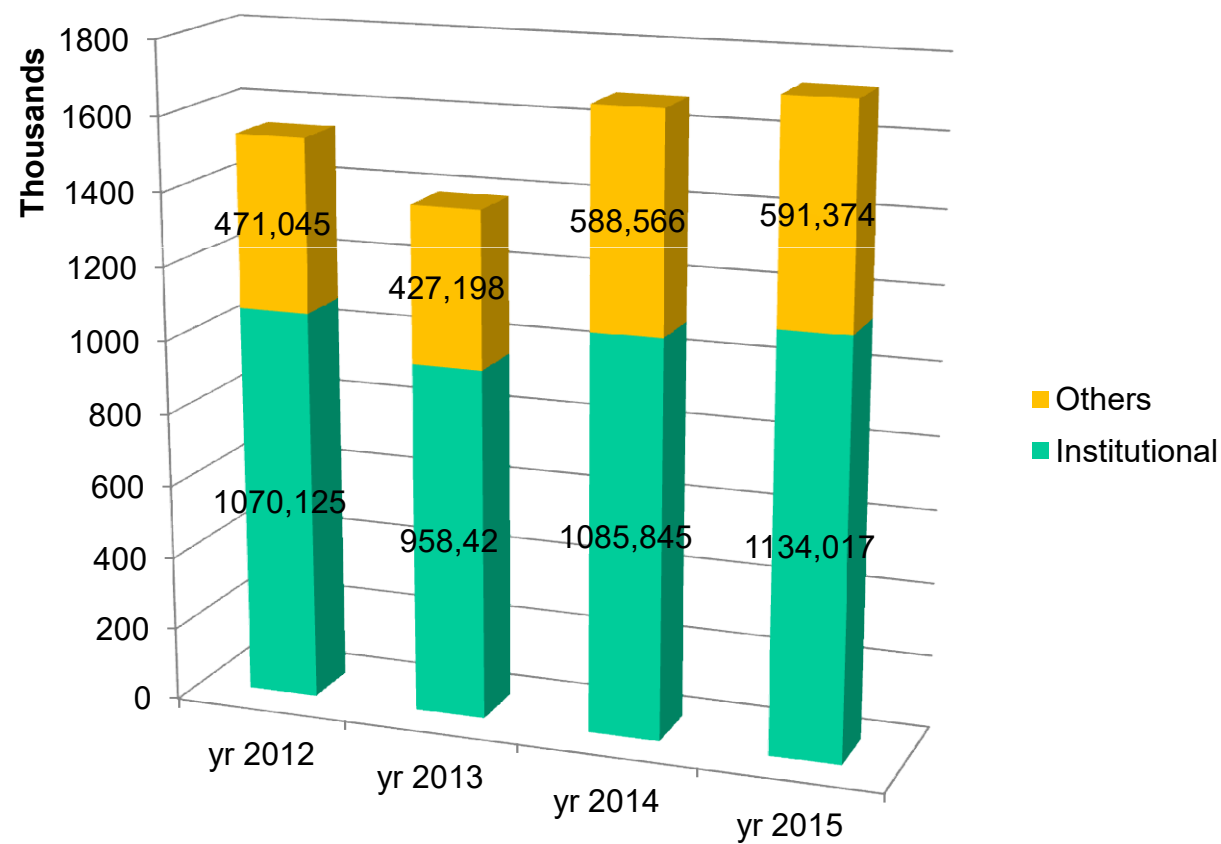


Technological transfer: Brokerage centre

TransTech Burza 2014, 2015

Economy

Income (excluding EUSF)



Popularization

Each year

- Researcher's Night
- Open Day within the European Science and Technology Week

2012 – 2 TV documentaries

2012 – 2 documentaries within ISWA project

2013 – 1 TV documentary

2014, 2015 – TransTechBurza – technology transfer meeting: academia+industry

2015 – 2 x one hour pop. tech. local radio broadcasting

- Regular lectures, workshops and talks for industrial partners, students, visitors, schools, etc.,
- Presence on internet, local press,...



PhD study

Accredited program: **Material Science and Engineering**

in Collaboration with Faculty of Metallurgy, Technical University, Košice

	2012		2013		2014		2015	
	No	defs	No	defs	No	defs	No	defs
Internal	13	0	13	3	15	1	14	3
External	2	0	1	1	1	0	1	0
Potential Supervisors	20		20		20		20	

PhD study

Foreign PhD students with their own funding on work stays at IMR SAS

- 2013 T. Csanádi, Hungary, 55 days
- 2014-15 V. Kuzma, Ukraine, 10 months
- 2015 R. Husák, Czech Republic, 39 days
- 2015 B. Cheniti, Algeria, 31 days (2016-9 months)
- 2015 M. Klich, Poland, 60 days

IMR PhD students abroad:

- 2012 A. Duszová, Poland, 55 days
- 2013 A. Duszová, Poland, 36 days

Stefan Schwartz Fund holders:

- 2012 – Dr. P. Tatarko
- 2014 – Dr. A. Naughton-Duszová
- 2016 – Dr. J Balko (approved 2015)

Other pedagogical activities: lectures, supervision and reviewing of diploma and bachelor theses – TUKE, UPJŠ, STU, etc.



Selected scientific results



Basic research – International project

Resistance of Titanium-Niobium alloys against high temperature oxidation

Project: FP7-PEOPLE-2007-1-1-ITN “MAMINA”, Ing. Karel Saksl, DrSc

Experimental proof that Ti alloys with low amount of Nb (up to 2 wt.%) possess highly improved high temp. oxidation resistance above 550 °C.

Explanation was given for the first time.

- Nb, V and Zr have practically zero solubility in titanium oxides,
- Nb and V do not precipitate, they dissolve in hcp α -Ti matrix,
- Nb atoms – slow diffusion into Ti matrix – they create a strong barrier on alloy surface – eliminate further oxidation,
- in process oxides drive away the Nb, its concentration increases to critical level of 2.2 wt.% and new protective barrier is created,
- effective concentration of Nb in the alloy is 1 wt.%.

The Metallurgy and Material Society of CIM: 2015 Light metals best paper award.



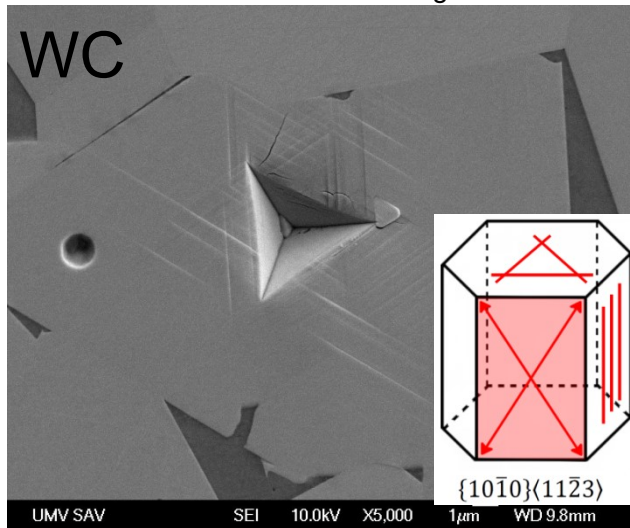


Anisotropy of mechanical properties of ceramic grains (single crystals) in sintered materials on micro and nano scales

2014-2015 - 6 CC papers and counting, 15 citations

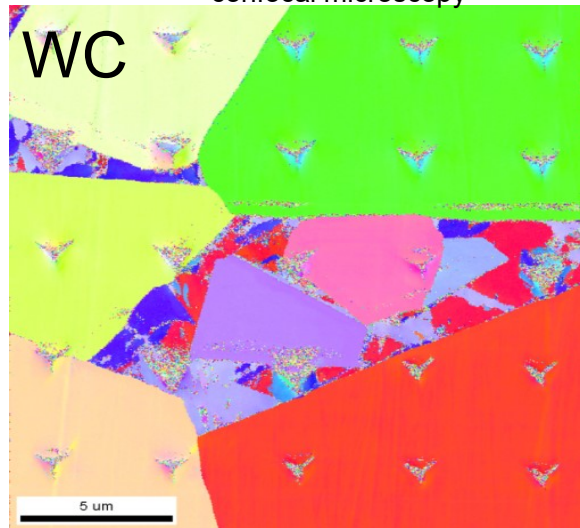
Testing

- Nanoindentation
- Micropillar compression
- Nanoscratch testing



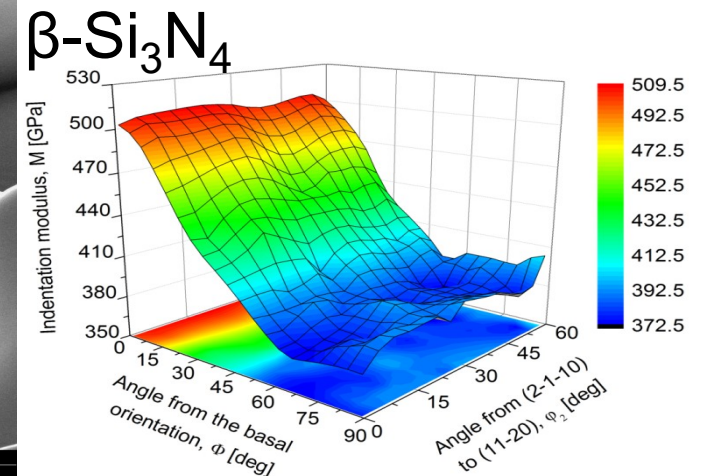
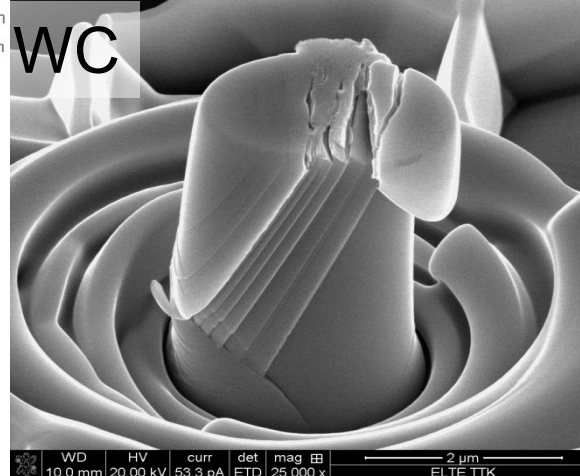
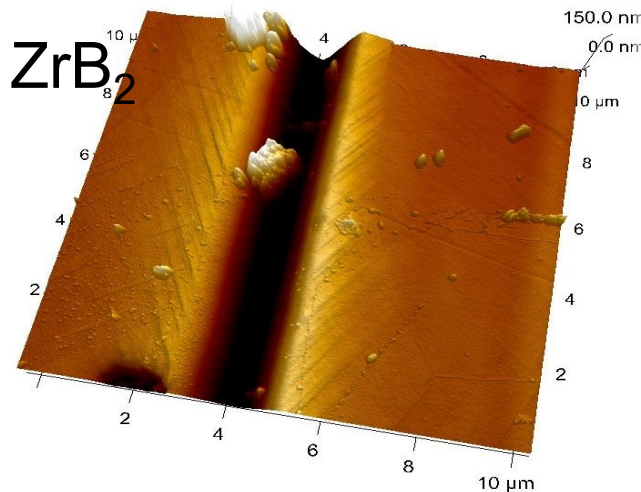
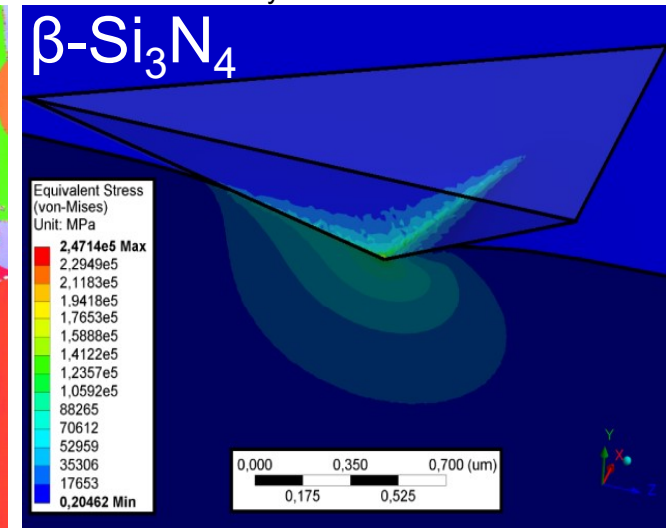
Observation

- SEM/FIB/EBSD
- AFM
- confocal microscopy



Modeling

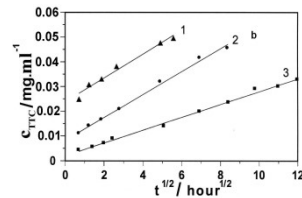
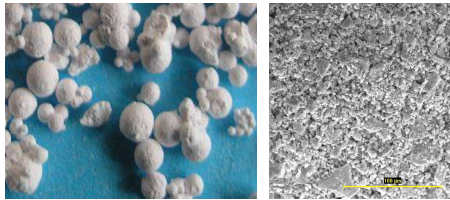
- Numerical (FEM, XFEM)
- Analytical models





Calcium phosphate and composite substrates for reconstruction and regeneration medicine

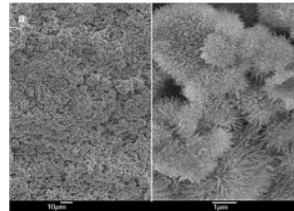
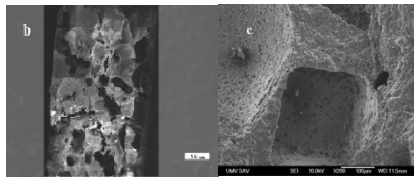
Porous ceramic granules for bone defect filling
Control release of drugs and bioactive substances



Controlled release of antibiotics

Patented preparation of ceramic substrates

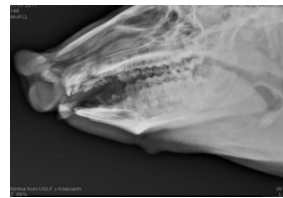
Highly porous ceramic substrates and self-hardening biocements for reconstruction defects of hard tissues



Macroporous hydroxyapatite ceramic substrates

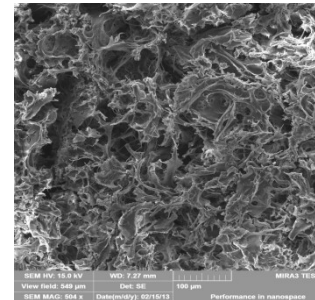
Hardened biocement

Patented preparation of calcium phosphate biocements

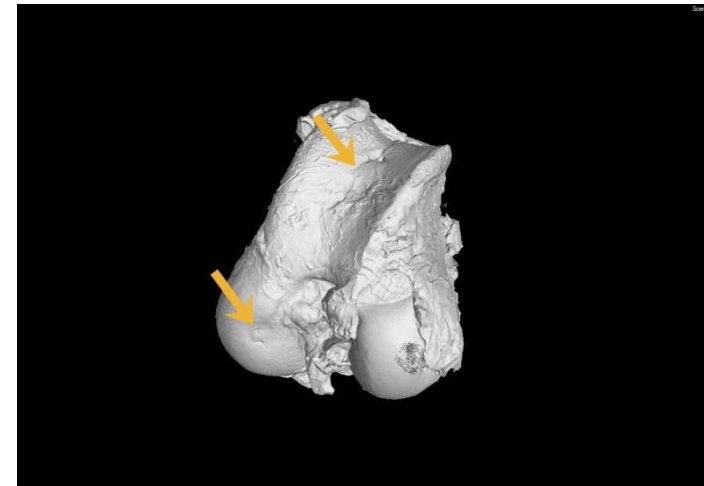


Implantation of hydroxyapatite ceramic substrates to mandible of pigs and after 10 weeks of healing

Development of novel 3D composite biopolymer system for treatment of soft tissues



3D macroporous substrate for reconstruction of cartilages



CT image of cartilage defects in sheep knee with our implants after 20 weeks of healing -first pre-clinical study

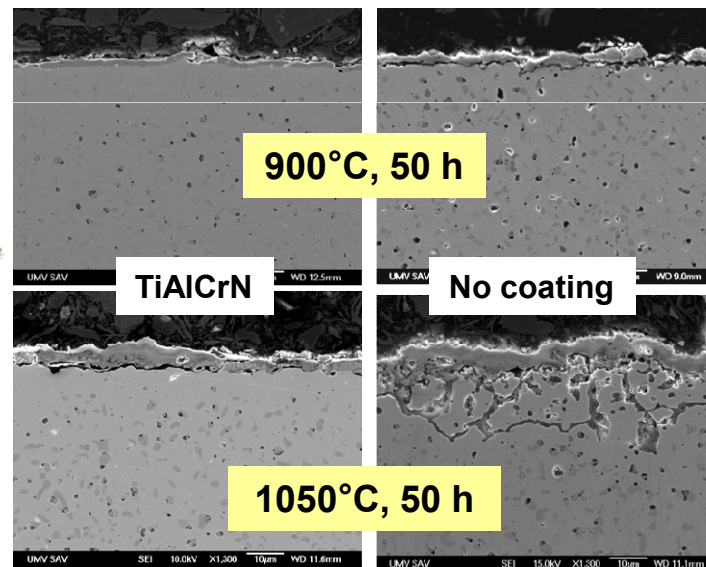
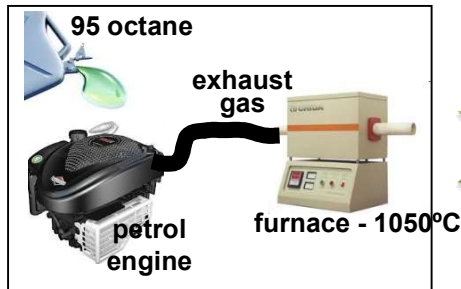
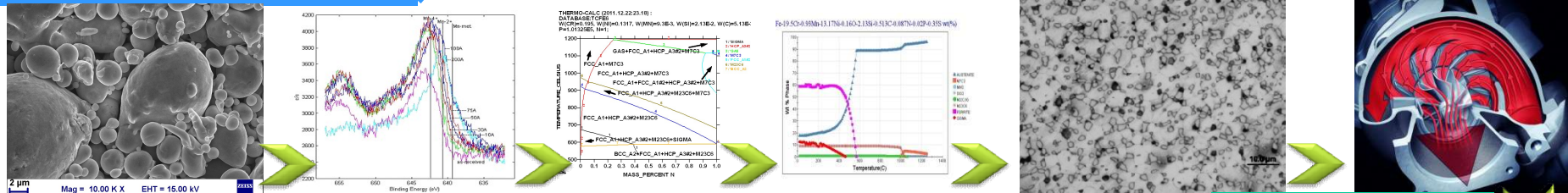
High temperature properties of PM components for turbocharger applications

Höganäs Chair V



Contract research

Develop. 20%Cr-[Ni,Si,Mn]-C sintered material



Solution:
Application of TiAlCrN coating and creation of protective Cr and Si oxidic layer as effective barrier against oxidizing processes at working temperatures.

**Tensile props.
20-800°C**

**Wear
20-900°C**

**Creep
900 and 1050°C**

**Hi temp properties
correspond to required
values.**

**Oxidation –
Exhaust gases
900 and 1050°C**

**Degradation in aggressive
oxidizing environ.**

Results and suggestions of previous assessment

- 1) To adapt the structure of departments according to the new research objectives.

Restructuralization – prepared over 2015, entered in force since 01/01/2016:

3 scientific Divisions:

- 1) Metallic materials,
- 2) Ceramic and non-metallic materials
- 3) Hybrid and functional materials, respectively.

Larger, roughly similar size, comparable project potential and experimental capabilities.

The scientific divisions are supported by two service units:

- 1) administrative support
- 2) technical support.

Furthermore, during 2015, two new units were established:

- 1) Unit of project support (project management)
- 2) Brokerage centre (technology transfer and outreach)

Results and suggestions of previous assessment

2) To build up laboratories equipped with the preparation techniques.

New laboratories have been built, significant investment have been devoted.

3) To improve significantly the activities in the field of transfer of knowledge to the industry.

PROMATECH activities, Brokerage centre (regular workshops for industrial partners),

- Member of two clusters: IT+R (IT and Robotics), eFusion (energy)
- member of National technological platform for raw materials

4) Special care should be given to use the new equipment effectively, both from point of view of managing them personally and finding some new attractive and useful research problems.

New equipment is primarily managed by those responsible for their acquiring with the greatest interest in using it. Still the greatest challenge – staff funding.

Vision and strategy

High-tech materials for Industry 4.0 in accord with the Research and Innovation Strategy for Smart Specialization of the Slovak Republic RIS3SK

High tech materials

- automotive industry, electric and hybrid engines, hydrogen storage and usage,
- ceramics with carbon allotropes and other ceramics for extreme conditions, protective and functional coatings, smart fibers
- functional hybrid materials - modern multi-scale micro/nano powder composites (advanced processing, SPS, MWS, micro-MIM, Additive manufacturing, etc.,
- biomedicine (biodegradable materials prepared from powder metals - coatings of bioceramic/biopolymer deposited on the surface of the metallic biomaterials).

New project applications

- 2 projects of **Long-term strategic research of SR**, (+1 in preparation)
- 6 projects of **Industrial research centers**
- Preparation of **2 H2020 projects, ERA project**

methods

- find and implement effective measures for further development,
- decrease the administrative burden,
- strengthen the position of IMR SAS to a European-wide standard by being engaged in European international projects (Horizont 2020, ERA projects, ESA schemes, etc), strong collaborations.



Thank you

