DEPARTMENT FOR NANOSTRUCTURED MATERIALS K-7

The basic and applied research in the Department for Nanostructured Materials includes ceramic materials, metals, intermetallic alloys and minerals. Our research encompasses conventional processing as well as the development of new technologies and methods for preparing new materials with novel properties. It includes experimental and theoretical investigations of structures, analyses of chemical compositions at the atomic level, and measurements and calculations of physical properties, all of which help us to improve the properties of micro- and nanostructured materials.

Head:
Prof. Spomenka Kobe

One-dimensional and two-dimensional **Fe-Pd-based nanostructures** were prepared on conductive substrates and via template-assisted electrodeposition into high-aspect-ratio polycarbonate membranes. The deposition process was found to be kinetically controlled, and therefore the targeted composition of $Fe_{50}Pd_{50}$ was adjusted using the applied potential. The annealing was performed in forming gas in order to transform the cubic Fe-Pd into tetragonal Fe-Pd, which has a high magnetocrystalline anisotropy. The coercivity of 80 kA/m in the out-of-plane direction was achieved with a modest heat treatment at 400°C for 1h, where the other reactions like grain growth, sintering and interdiffusion were sluggish. Tubular, Fe-Pd nanostructures were obtained directly, without any pore-wall functionalization, as was previously reported in the literature. The mechanism of direct tube formation was attributed to the appropriate relative rates of the deposition and the diffusion of the Fe^{2+} and Pd^{2+} ions into partially Au-covered pores. It was found that diffusion is the rate-determining step of the electrodeposition process; therefore, the composition and the related properties can be controlled via the electrolyte composition. The highest obtained coercivity for Fe-Pd nanotubes was 150 kA/m, which makes these materials interesting for **advanced electronic and magnetic devices**, as media for **high-density magnetic recording**. Another composition of $Fe_{70}Pd_{30}$ was also investigated due to its magnetic-shape-memory effect, where strains up to 10% can be achieved in modest fields. Thin films as well as nanotubes with an appropriate composition were synthesized and the work proceeds with the functionalization of the $Fe_{70}Pd_{30}$ nanotubes towards their **use as a drug-delivery agent**.

High-resolution scanning electron microscopy (FEGSEM) combined with complementary atomic force microscopy (AFM) and with electron-probe microanalytical methods, i.e., energy-dispersive and wavelength-dispersive X-ray spectroscopies (EDXS, WDXS), were applied to study different materials on the micro- and nanoscale. Among others we have studied the morphology, distribution and the size of nanoparticles and have determined the chemical composition of submicrometer thin films of the ferromagnetic alloys Co-Pt and Fe-Pd, which were obtained by electrodeposition. In this case the microanalytical approach using the EDXS and the WDXS was improved and adjusted for nanometre-scale analysis, taking into account specific anomalies related to the spectroscopy of the Co-L and Fe-L spectral lines. As a result we have implemented an optimized, reliable approach for accurate quantitative elemental analysis of the Co-Pt and Fe-Pd thin films. The obtained results allowed us to define the influence of process parameters of electrodeposition on the thickness and the composition of Co-Pt and Fe-Pd films as well as to correlate the composition with magnetic properties of these materials.

The magnetic response of individual Co-Pt, Fe-Pd nanospheres and nanotubes was measured and quantified for the first time in this system by applying Electron Holography (EH) in a Cs-corrected Tecnai F20 operated in magnetic-field-free Lorentz mode. EH is the only method that can visualize and quantify the magnetic properties inside and outside individual nanostructures with nanometre sensitivity.

We continued our work on **quasicrystals** as a promising material for **hydrogen storage** by performing melt-spinning experiments on Ti-Zr-Ni-Cu alloys with various compositions: $Ti_{40}Zr_{40}Ni_{20}$, $Ti_{45}Zr_{38-x}Ni_{17}Cu_x$ (x=3.5), $Ti_{53}Zr_{27-x}Ni_{20}Cu_x$ (x=3.5) and $Ti_{58}Zr_{24-x}Ni_{18}Cu_x$ (x=3.5). We were mainly interested in the formation of the icosahedral quasicrystalline phase (i-phase). Using this technique we prepared a series of samples under identical conditions, varying only the composition. XRD results showed that the i-phase is formed over a relatively wide range of compositions. With a higher titanium-to-zirconium ratio the quasicrystalline lattice constant a_q was found to linearly decrease. Using mass-spectrometry of the desorbed hydrogen we discovered that the **bonding energy of hydrogen** depends only on the structure of material, and not on the composition nor on the content of the bonded hydrogen. Decreasing the saturation magnetization and the susceptibility by about 30 % was determined for hydrided Ti-Zr-Ni quenched rods of diameters 3, 2 and 1.5 mm. The most important discovery was a selective hydrogenation of crystalline Ti-Zr-Ni samples within a narrow range of compositions. At the edge of this area we found that if we added 1 at.% more Ti the hydrogen content drops from 2 mass% to below 0.1 mass% H. This phenomenon was not observed for quasicrystalline samples, which indicates their better oxidation resist-

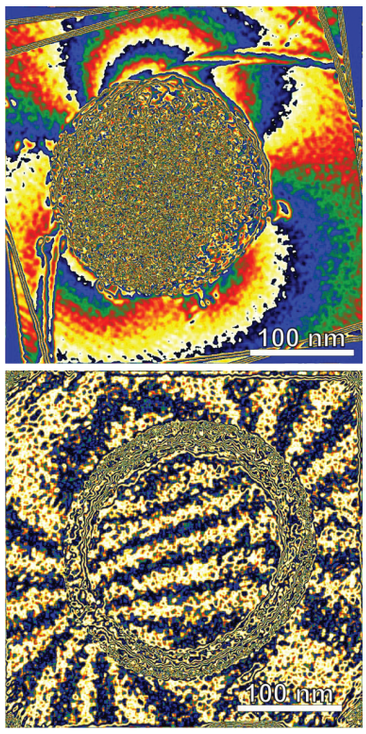

Figure 1: Magnetic field of CoPt nanosphere visualized by electron holography (above). Magnetic field of FePd nanotube visualized by electron holography (below).

ance. With XPS analysis we found a 5-times thicker oxide layer on non-absorbing samples after hydrogen treatment. We believe that the reason for such performance is the different structure in the density of states at the Fermi level, which we are going to prove by measurements of the Pauli susceptibility using PPMS device, by resistivity measurements, and by XAS analysis.

In the frame of the EU's MNT ERA-Net project "**Hydrogen-impermeable nanomaterial coatings for steels** (Hy-nano-IM)" we are investigating the possibility of producing **hydrogen-impermeable coatings** for steels for the long-term storage and transport of gaseous and liquid hydrogen. We have recently achieved outstanding success with a newly developed TiAlN-based coating, which when applied as a 5-μm-thick layer to the steel is able to reduce the permeation of hydrogen through the material by as much as 17,000 times. Transmission electron microscopy studies have revealed that close to the steel substrate the TiAlN forms in nanometre-sized grains, with columnar grains extending towards the surface of the coating.

We started with a new PhD-studies project looking at the effects of heavy-rare-earth substitutions on the coercivities of **Nd–Fe–B-based magnets**. In collaboration with Shinetsu, Japan, we are looking quantitatively at the extent of the Tb diffusion along the magnet's grain boundaries. Also related to Nd–Fe–B magnets, we have conducted a successful high-resolution SEM study to determine the origin of the **anisotropic hydrogen decrepitation** effect observed in aligned, sintered magnets. Using carefully prepared, partially hydrided samples, we were able to observe the presence of aligned, parallel cracks within the individual $Nd_2Fe_{14}B$ grains. These results will be published in J. Appl. Phys. in May of 2010.

In the field of intermetallic alloys with **magnetocaloric properties** we continued our research in the frame of European Network of Excellence **NoE CMA** (Complex Metallic Alloys) by studying the influence of the iron substitutions in the Gd-Si-Ge matrix phase. We observed very significant differences in terms of the macrostructures, microstructures and magnetic properties. The large magnetocaloric effect is a consequence of the structural transition, which occurs at the same time as the magnetic transition. Additions of iron suppress this transition. The research was performed on the Gd-Si-Ge system with a low temperature X-Ray diffractometer. We were interested on the effect of Fe on the structural suppression. The results showed that when substituting Si, the magnetic measurements showed a second-order transition with no structural change, but the X-ray showed that a structural transition still takes place. Research has also been done on a new system: Gd-based metallic glasses show interesting mechanical, electrical and magnetic properties. The magnetocaloric effect is comparable with pure Gd, but with the peak at lower temperatures. It is interesting that the Curie temperature shifts to lower temperatures with higher fields and can change by as much as 20 degrees.

As part of our investigations of Gd–Ge–Si-based magnetocaloric materials we have looked at the role of surfactants in producing high-aspect-ratio flakes for improved packing densities in **magnetocaloric elements**. By adding small amounts of oleic acid we were able to produce Gd–Ge–Si flakes, while retaining the material's crystal structure, during high-energy milling.

Sm-Fe-Ta-N-based **magnetic core-shell nanospheres**, showing a crystalline core and an amorphous shell structure were investigated by employing state-of-the-art techniques of TEM. A detailed analysis procedure was developed to extract the structure and the composition of the core and the shell separately. The obtained, combined structural and compositional information is essential for explaining the fundamental thermodynamics, which dominates the formation of intermetallic core-shell droplets, and the associated magnetic interactions at the nanoscale.

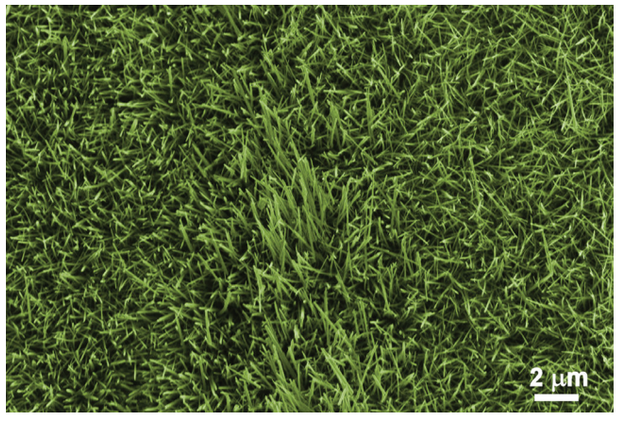

Figure 2: Nano meadow: TiO_2-Al_2O_3 crystals grown from the Ti6Al4V alloy during thermal treatment in Ar 99.99

The magnetic response of individual **Co-Pt, Fe-Pd nanospheres and nanotubes** was measured and quantified for the first time in this system by applying **Electron Holography (EH)** in a Cs-corrected Tecnai F20 operated in a magnetic-field-free Lorentz mode. EH is the only method that can visualize and quantify the magnetic properties inside and outside individual nanostructures with nanometre sensitivity. The phenomenon of charge-density wave (CDW) formation was studied by high-resolution transmission electron microscopy and electron diffraction performed on pure Nb_3Te_4 at room- and liquid-nitrogen temperatures. The study revealed both the basic structure and the low-temperature charge-density waves (CDWs) modulation.

Technologically interesting properties of materials were studied within the framework of the density-functional theory. We were focused on the **calculations of transport properties** in the approximants of quasicrystals and the alloys that exhibit a magnetocaloric effect by applying the semi-classical Boltzman theory and the relaxation-time approximation. We started with investigations in the field of nanotribology, where we will model a DLC surface in the presence of various lubricants.

The investigations in the frame of the FP6 project "Meddelcoat" have been focused on the development of new, bioactive coatings on metallic body implants with a highly porous surface layer. We studied the effect of process parameters in a hydrothermal treatment of the Ti6Al4V alloy on the structure and properties of the TiO_2 coating and as a result we prepared a coating with biocompatible, bioactive, photocatalytic and after UV irradiation hydrophilic properties. We also developed a sol-gel synthesis technique for the production of nanosized bioactive glass powder. Based on analyses of their electrokinetic properties we prepared a stable suspension that enables the preparation of a thin coating with suitable properties.

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In accordance with the direction of EFDA, the development of ceramic matrix composites SiC_f/SiC (FP7-Euratom/Fusion) has been reoriented in increasing the thermal conductivity of the composite. With this aim we performed a feasibility study of the incorporation of carbon nanotubes or tungsten. Using electrophoretic deposition we applied a thin coating (<100 nm) of CNTs on a SiC fibre mat that was further infiltrated in an electric field with a SiC-based suspension. As alternative densification technique we also verified an adapted technique of infiltration with pre-ceramic polymer.

We started with preliminary investigations of self-assembly of titania particles in anatase crystal form. We studied the influence of various parameters (temperature, time, pH, added dopants, etc.) of the hydrothermal synthesis on the size and morphology of particles. Using specific dopants we tried to induce the formation of twins, which would eventually lead to the fractal growth of the crystals. Synthesized particles were thoroughly investigated using electron microscopy and microanalytical methods, and the crystal planes where the preferential crystal growth took place were determined.

We continued with our study of the nucleation and crystallization of various nanomaterials. We explained the formation of ZnO bipods where very small amount of silicon was present on inversion-domain boundary, which is positioned at the middle of crystal. Although this morphology has been known for years we were the first to publish the explanations of its origin. We investigated the self-assembly of Ge quantum dots in an amorphous silica matrix and the crystallization of TiO_2–CeO_2 during in-situ heating experiments inside the transmission electron microscope. Together with the industrial partner Cinkarna Celje we studied the processing parameters for the synthesis of **TiO_2 nanoparticle**s with rutile and anatase structures and investigated the chemical composition and the structure of nanometre-sized Al_2O_3-SiO_2 coatings on the top of TiO_2 rutile particles, which improve the optical and chemical properties of the pigment.

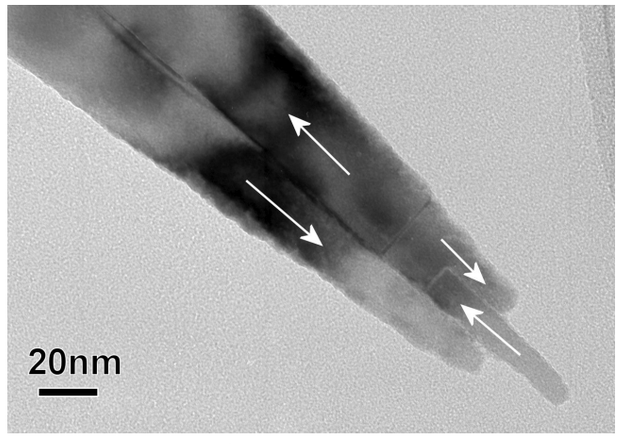

Figure 3: Terminal pair of ZnO bipods where the prismatic and basal inversion domain boundaries (IDBs) are clearly seen. Arrows indicate the polar axes [0001](+c direction).

The synthesis of ZnO nanopowders from water solutions of ZnO-nitrates by precipitation and hydrothermal methods was studied. The influence of the Zn^{2+} concentration in solution, pH, type, quantity and concentration of the added precipitation agent on the solution equilibrium and consequently the type, morphology and crystallinity of the precipitation product was analyzed. The processing parameters resulting either in the formation of square-shaped $Zn(OH)_2$ platelets with nanometre thickness or ZnO powders with a particle size of about 100 nm were determined. The influence of the type and morphology of the powder obtained by precipitation and used for hydrothermal synthesis, concentration of suspension, pH, temperature and time on the growth, morphology and crystallinity of the ZnO obtained by hydrothermal synthesis was investigated. The parameters that enable the reproducible preparation of ZnO powders with a morphology of either whiskers or plates, with a size in the range from 100 nm to 10 mm, were determined.

We continued with the studies of the microstructure development in ZnO-based ceramics for very low additions of Bi_2O_3 and Sb_2O_3, under the influence of inversion boundaries (IBs). The amount of Bi_2O_3 liquid phase at the grain boundaries crucially affects the grain growth under the influence of inversion boundaries (IBs), which are triggered by the addition of Sb_2O_3. Based on the findings we were able to prepare homogeneous, coarse-grained varistor ceramics with an average ZnO grain size of about 40 mm, a low threshold voltage below 70 V/mm and a coefficient of nonlinearity above 40. These studies enabled us to reproducibly prepare low-doped varistor ceramics with the addition of only about 3 wt.% of varistor dopants (typical addition about 10 wt.%) with an excellent current-voltage nonlinearity – threshold voltage in the range from 60 to 350V/mm, coefficient of nonlinearity from 30 to 50 and leakage current below 1 mA.

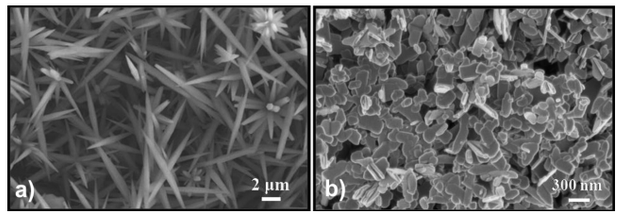

Figure 4: ZnO powders prepared by hydrothermal synthesis at 100°C from a) suspension of $Zn(OH)_2$ and b) ZnO.

We successfully finished the development of low-capacity varistor ceramics for applications in telecommunications systems. The main microstructural parameters (ZnO grain size, amount of secondary phases at the grain boundaries, nature of the grain boundaries) that can be influenced by processing parameters (starting composition and amount of varistor dopants added to ZnO, temperature and time of sintering), which influence the capacity of varistor ceramics and can be tailored to reduce it at a given thickness of ceramic and electrode surface, were determined. Based on the findings varistor ceramics with several times lower capacity were developed.

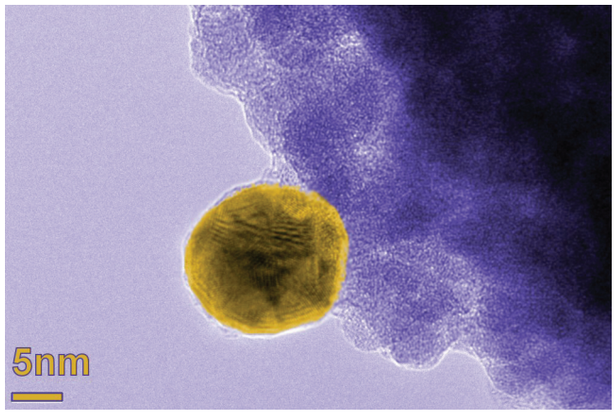

Figure 5: Crystalized Au nanoparticle on amorphous TiO_2.

Perovskite $BaTiO_3$, $(Ba,Sr)TiO_3$ and TiO_2 **nanorods** and $SrTiO_3$ **nanotubes** were synthesized by sol-gel electrophoretic deposition into track-etched hydrophilic polycarbonate (PC) membranes and/or anodic aluminium oxide (AAO) membranes. The stability of the sols and the optimization of the parameters for electrodeposition were a prerequisite for successful synthesis. The obtained nanorods and nanotubes were polycrystalline in nature with diameters ranging from 100 to 250 nm and grain sizes from 25 to 50 nm. Electron diffraction studies and high-resolution TEM revealed that $BaTiO_3$ nanorods consist of all three polymorph structures (cubic, tetragonal and hexagonal). Electrical conductivity measurements on a single $BaTiO_3$ nanorod as a function of temperature showed that the $BaTiO_3$ nanorods exhibited the NTC effect. The $SrTiO_3$ nanotubes were composed of ordered cubic nanocrystals exhibiting a texture, which was proven by 3D electron tomography and electron diffraction.

One of important research areas of the group is the **implementation** and **development** of various **electron microscopy analytical technique**s within the existing EU project "ESTEEM", such as electron energy-loss spectroscopy (EELS), high-resolution scanning transmission electron microscopy (STEM, HAADF-STEM) electron holography, 3D electron tomography and mechanical preparation of the TEM samples. In atomically resolved HAADF-STEM we were among the first to show, on model ceramic materials $CaTiO_3$, $SrTiO_3$ and $BaTiO_3$, that the local lattice distortions, apart from chemical composition, significantly influence the experimentally determined intensities of single atom columns. In this sense, the quantitative structural and compositional analysis of Ruddlesden-Popper faults was performed using combined high-resolution transmission electron microscopy (HRTEM) and high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) analyses. In this study we demonstrated that local planar structural defects can be fully reconstructed and quantified, meaning that the type and position of the atoms inside the investigated structure can be precisely determined.

The quantitative structural and compositional analysis of Ruddlesden-Popper faults was performed by combined high-resolution transmission electron microscopy (HRTEM) and high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) analyses. We demonstrated that local planar structural defects can be fully reconstructed and quantified, meaning that the type and the position of the atoms inside the investigated structure can be precisely determined.

Another new analytical method was developed, called concentric electron probe. CEP is a new spectroscopic method for measuring extremely low amounts of dopants on grain boundaries and 2D defects in crystals on the subnanometer scale. The method is dedicated to determining the fine structural elements at the initial stage of the phase transformations by providing up to two orders of magnitude more accurate results compared to the existing analytical TEM methods. The technique was originally developed on the inversion boundaries in ZnO, and nowadays it is widely used in solving the defect structures in various natural and synthetic materials.

The research group is additionally strongly involved in managing of the **Center for Electron Microscopy** within the frame of national infrastructure Center for Microstructural and Surface Analysis. The implementation of various electron microscopy analytical techniques and the possibility for researchers to access research infrastructure for electron microscopy is of utmost importance for numerous research institutions, industrial partners, as well as for graduate and post-graduate education.

Some outstanding publications in 2009

1. Paul J. McGuiness, Andraž Kocjan, Spomenka Kobe. Permanent magnets based on nanostructured intermetallic alloys. V: Cristian I. Contescu (ed.), Karol Putyera (ed.), James A. Schwarz. *Dekker encyclopedia of nanoscience and nanotechnology*. 2nd ed. Boca Raton: CRC Press: imprint of the Taylor & Francis Group, cop. 2009, pp. 3328-3335.
2. Benjamin Podmiljšak, Paul J. McGuiness, Blaž Miklavič, Kristina Žužek Rožman, Spomenka Kobe. Magnetocaloric properties and nanoscale structure of Fe-doped $Gd_5Ge_2Si_2$ alloys. *J. Appl. Phys.*, 2009, vol. 105, no. 7, pp. 07A941-1-07A941-3.

3. Saša Novak, Uroš Maver, Špela Peternel, Peter Venturini, Marjan Bele, Miran Gaberšček. Electrophoretic deposition as a tool for separation of protein inclusion bodies from host bacteria in suspension. *Colloids surf., A Physicochem. eng. Asp.*, 2009, vol. 340, no. 1/3, pp. 155-160.
4. Sašo Šturm, Miran Čeh. Atomic-scale structural and compositional analyses of Ruddlesden-Popper planar faults in AO-excess $SrTiO_3$ ($A = Sr^{(2+)}$, $Ca^{(2+)}$, $Ba^{(2+)}$) ceramics. *J. mater. res.*, 2009, vol. 24, no. 8, pp. 2596-2604.
5. Maja Buljan, Goran Dražić. Formation of long-range ordered quantum dots arrays in amorphous matrix by ion beam irradiation. *Appl. phys. lett.*, 2009, vol. 95, no. 6, pp. 063104-1-063104-3.

Patent applications

1. P-200900340, Anatase nanoparticles and procedure for synthesis of anatase nanoparticles: patent application, Dejan Verhovšek, Tatjana Rožman, Miran Čeh, Pavel Blagotinšek, Sašo Šturm, Kristina Žagar, Slovenian Intellectual Property Office, Ljubljana, Slovenia, 14 November 2009
2. P-200900340, Rutile nanoparticles and procedure for synthesis of rutile nanoparticles: patent application, Dejan Verhovšek, Tatjana Rožman, Miran Čeh, Pavel Blagotinšek, Sašo Šturm, Kristina Žagar, Slovenian Intellectual Property Office, Ljubljana, Slovenia, 14 November 2009

Awards and appointments

1. Alenka Lenart: "Structural analysis of twins in quartz"; Winning poster contribution at the International School of Crystallization "La Factoria", Granada, Spain, 25–29 May 2009; International Union of Crystallography, Ministerio de Ciencia e Innovación Superior de Investigaciones Cientificas.
2. Darja Pečko: "Electrodeposition and characterization of Fe-Pd magnetic thin films". Winning contribution of young scientists at the 17th Conference on Materials and Technologies in the field "Nanomaterials and Nanotechnology", Portorož, Slovenia, 16–18 November 2009.

Organization of conferences, congress and meetings

1. Fusion EXPO, Fuzija, energija prihodnosti, Galerija Kresija, 10–20 March 2009 (co-organisation)
2. AdSTEM2009, Workshop on Quantitative HAADF-STEM imaging and EELS, Piran, Slovenia, 11–14 October 2009
3. 17th Conference on Materials and Technology, 16–18 November 2009 (co-organisation)
4. European School in Materials Science: Mechanical Properties of Complex Metallic Alloys, Ljubljana, Slovenia, 25–30 May 2009 (co-organisation)
5. 9 Multinational Conference on Microscopy – MC2009, Graz, Austria, 30 August – 4 September 2009 (members of International Advisory Board)
6. 2009 EFDA Public Information Group Meeting, Ljubljana, 14–15 May 2009
7. Project Meeting FP6 RII3 ESTEEM: "Enabling Science and Technology for European Electron Microscopy", Ljubljana, 14 September 2009

INTERNATIONAL PROJECTS

1. Nanoscale of Tribological Interfaces for Clean and Energy-Efficient Diesel and Gasoline Power Trains
   2020 Interface, EU FP7
   234324, SCP8-GA-2009-234324
   EC; Jackie Kidd, PA - Support Officer to Director of Research, Institute of Engineering Thermofluids, Surfaces and Interfaces, School of Mechanical Engineering, The University of Leeds, Leeds, Great Britain
   Asst. Prof. Matej Komelj
2. Merging Atomistic and Continuum Analysis of Nanometer Length-scale Metal-oxide Systems for Energy and Catalysis Applications
   MACAN, EU FP7
   233484, NMP3-CA-2009-233484
   EC; Prof. Wayne Kaplan, Technion - Israel Institute of Technology, Haifa, Israel
   Dr. Aleksander Rečnik
3. Improving the Gender Diversity Management in Materials Research Institutions
   DIVERSITY, EU FP7
   230253
   EC; Leibniz-Institut fuer Festkoerper- und Werkstoffforschung, Dresden, Germany
   Prof. Spomenka Kobe
4. Cooperation of Space NCPs as a Means to Optimise Services
   COSMOS, EU FP7, 218813
   EC; Dr. Adrien Klein, Deutsches Zentrum für Luft und Raumfahrt e.v., (DLR), Köln, Germany
   Prof. Spomenka Kobe, Dr. Boris Pukl, Dr. Špela Stres
5. Property Requirements for SiC/SiC Composites as Structural Materials, 4.1.1.1.-FU
   EURATOM – MHEST
   EU FP7, EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education and Technology, Ljubljana, Slovenia
   Asst. Prof. Goran Dražič, Asst. Prof. Saša Novak Krmpotič
6. Development of Composites with Advanced/Alternative Manufacturing Concepts, 4.1.1.2 FU
   EURATOM – MHEST
   EU FP7, EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education and Technology, Ljubljana, Slovenia
   Asst. Prof. Saša Novak Krmpotič, Asst. Prof. Goran Dražič
7. SiC/SiC Composite for Structural Application in Fusion Reactor, A-2 FU
   WP08-09-MAT-SiSiC
   EURATOM – MHEST
   EU FP7, EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education and Technology, Ljubljana, Slovenia
   Asst. Prof. Goran Dražič

8. Public Information; Research Unit - Administration and Services - RU-FU
   EURATOM – MHEST
   EU FP7, EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education and Technology, Ljubljana, Slovenia
   Asst. Prof. Saša Novak Krmpotič, Prof. Milan Čerček
9. Fusion Expo Activities under an EFDA
   WP08-PIN-FUSEX
   EURATOM – MHEST
   EU FP7, EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education and Technology, Ljubljana, Slovenia
   Asst. Prof. Saša Novak Krmpotič, Melita Lenošek, B. Sc.
10. Multifunctional Bioresorbable Biocompatible Coatings with Biofilm Inhibition and Optimal Implant Fixation
    EU FP6, MEDDELCOAT
    NMP3-CT-2006-026501
    EC; Prof. Jozef Vleugels, Katholieke Universiteit Leuven, Research & Development, Leuven, Belgium
    Asst. Prof. Saša Novak Krmpotič
11. Enabling Science and Technology through European Electron Microscopy
    ESTEEM, EU FP6, 026019
    EC; Prof. Gustaaf Van Tendeloo, Universiteit Antwerpen, Antwerpen, Belgium
    Asst. Prof. Miran Čeh, Dr. Sašo Šturm
12. Complex Metallic Alloys
    CMA, EU FP6
    NMP3-CT-2005-500140
    EC; Centre National de la Recherche Scientifique, Paris, France
    Prof. Spomenka Kobe, Prof. Janez Dolinšek, Dr. Peter Panjan
13. Hydrogen Impermeable Nano-material Coatings for Steels
    Hy - Nano – IM, MNT ERA NET
    Asst. Prof. Paul McGuiness
14. Advanced Methods and Technologies for Processing of a New Generation of ZnO-based Varistor Ceramics
    BI-CN/09-11-017
    Dr. Zheng Liaoying, The Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China
    Dr. Slavko Bernik
15. Novel Magnetocaloric Materials for Ecological Refrigeration
    BI-CN/09-11-009
    Dr. Yan Gaolin, School of Physics and Technology, Wuhan University, Wuhan, China
    Asst. Prof. Paul McGuiness
16. Structural and Chemical Characterization of Titanate-based Nanorods and Nanotubes
    BI-CN/07-09-006
    Prof. Hui Gu, Shanghai Institute of Ceramics, Shanghai, China
    Asst. Prof. Miran Čeh
17. Enviromental Hydrogen-based Recycling of Nd-Fe-B Magnets
    BI-CN/05-07/008
    Dr. Gaolin Yan, Harbin Institute of Technology, ShenZhen Graduate School, XiLi, ShenZhen, China
    Asst. Prof. Paul McGuiness
18. Nanostructural Studies of Phase Transformations and Defect Structures in Iron Oxides and Sulphides
    BI-HU/09-10-007
    Prof. Mihály Pósfai, University of Pannonia, Department of Earth and Environmental Sciences, Veszprém, Hungary
    Dr. Aleksander Rečnik
19. Synthesis and Characterization of Nanostructured Catalytic Materials
    Sintese e Caracterizacao de Materiais Cataliticos Nanoestructurados
    BI-PT/08-09-003
    Dr. Adrian M.T. Silva, Faculdade de Engenharia da Universidade do Porto, Departamento de Engenharia Quimica, Laboratorio de Caralise e Materiais (Associado); Associated Laboratory LSRE/LCM, FEUP-University of Porto (Portugal), Porto, Portugal
    Asst. Prof. Goran Dražić
20. ZnO-Nanostructures for Novel Applications
    ZnO nanostrukturni materiali za nove primene
    BI-RS/08-09-015
    Dr. Zorica Branković, Institut za multidisciplinarne študije, Belgrade, Serbia
    Dr. Slavko Bernik

R & D GRANTS AND CONTRACTS

1. The influence of magnetic structure of materials on the magnetocaloric effect
   Asst. Prof. Matej Andrej Komelj
2. Ecotechnological 1D nanomaterials: synthesis and characterisation of 1D titanate nanomaterials doped with transition metal ions
   Dr. Polona Umek, Asst. Prof. Miran Čeh
3. Exploration and preservation of mineralogical heritage
   Dr. Aleksander Rečnik
4. Physics and chemistry of interfaces of nanostructured metallic materials
   Prof. Monika Jenko, Asst. Prof. Miran Čeh
5. Low-doped ZnO-based ceramics for energy varistors
   Dr. Slavko Bernik

RESEARCH PROGRAM

1. Nanostructured materials
   Prof. Spomenka Kobe

NEW CONTRACTS

1. VIZIPIN: A safe infrastructure for command and control
   Varsi, d. o. o.
   Dr. Slavko Bernik
2. WISEVAR: Varistors for protection of renewable energy systems
   Varsi, d. o. o.
   Dr. Slavko Bernik
3. Low-doped ZnO-based ceramics for energy varistors
   Iskra Protections, d. o. o.
   Dr. Slavko Bernik
4. Low-doped ZnO-based ceramics for energy varistors
   Varsi, d. o. o.
   Dr. Slavko Bernik
5. Exploration and preservation of mineralogical heritage
   Litija Municipality
   Dr. Aleksander Rečnik
6. Development of polymer varistors
   Varsi, d. o. o.
   Dr. Slavko Bernik

VISITORS FROM ABROAD

1. Prof. Hui Gu, Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China, 10–18 February 2009
2. Gao Xiang, Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, Kitajska, Shanghai, China, 10 February – 14 March 2009
3. Prof. Mihály Pósfai, Ilona Nyiro Kósa in Dorottya Sára Csákberényi Nagy, University of Pannonia, Veszprém, Hungary, 16–22 March 2009
4. Dr. Goran Branković, Institute for Multidisciplinary Studies, Belgrade, Serbia, 22–29 March 2009
5. Dr. Davor Gracin, Institut Rudjer Bošković, Zagreb, Croatia, 10 March 2009
6. Dr. Mehmet Ali Gülgün, Salih Buyukkilic and Yeliz Ekinci, Sabanci University, Istanbul, Turkey, 19–27 April 2009
7. Elke Fuchs, Universität Bayreuth, Bayreuth, Germany, 14 April – 7 June 2009
8. Prof. A. C. Cefalas, National Helenic Research Foundation, Athens, Greece, 28–30 April 2009
9. Prof. Ajayan Pulickel, Mechanical Engineering & Materials Dept., Rice University, Houston, Texas, USA, 6 May 2009
10. Dr. Andreja Gajović, Dr. Davor Gracin, Institut Rudjer Bošković, Zagreb, Croatia, 15 May 2009
11. Dr. Andreja Gajović, Institut Rudjer Bošković, Zagreb, Croatia, 25–31 May 2009
12. Dr. Alberto Bollero Real, Department of Energy, CIEMAT – Centro de Investigaciones Energéticos, Mediaoambientales y Tecnológicas, Madrid, Spain, 8–15 June 2009
13. Prof. Michael Coey, Trinity College, Dublin, Ireland; Prof. Jean Marie Dubois, Institut Jean Lamour, Nancy, France; Dr. Ester Belin - Ferré, Laboratoire de Chimie Physique Matière et Rayonnement – LCPMR-UMR, Paris, France, 29 May 2009
14. Geir Andreas Slotten, Norges Teknisk-Naturvitenskapelige Universitet, Trondheim, Norway, 30 June – 23 July 2009
15. Alexander Ford, Imperial College London, London, United Kingdom, 12 July – 2 October 2009
16. İsmail Özgür Özer, Anadolu University, Department for Materials Science and Engineering, Eskişehir, Turkey, 22 July – 1 August 2009
17. Dr. Goran Branković and Dr. Zorica Branković, Institut for Multidisciplinary Studies, Belgrade, Serbia, 7–19 August 2009
18. Milan Žunić, Institut for Multidisciplinary Studies, Belgrade, Serbia, 7–12 August 2009
19. Hahn Sven, Martin Luther Universität Halle/Wittenberg, Halle/Wittenberg, Germany, 3 August – 4 September 2009
20. Mrs. Marina Kutin and Prof. Milorad Davidović, Institut Goša, Belgrade, Serbia
21. Dr. Andreja Gajović, Dr. Davor Gracin, Institut Rudjer Bošković, Zagreb, Croatia, 18 September 2009
22. Dr. Andreja Gajović, Institut Rudjer Bošković, Zagreb, Croatia, 11–15 October 2009
23. Dr. Wolfgang Waldhauser, Dr. Jürgen Markus Lackner, Markus Kahn M.Sc., Mr. Harald Parizek, Joanneum Research Forschungsgesellschaft mbH Laserzentrum, Niklasdorf, Austria, 11 November 2009
24. Mrs. Marina Kutin and Prof. Milorad Davidović, Institut Goša, Belgrade, Serbia

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4. Asst. Prof. Goran Dražić
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7. Asst. Prof. Paul John McGuiness
8. Asst. Prof. Saša Novak Krmpotič
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11. Dr. Sašo Šturm

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16. Aljaž Iveković, B. Sc.
17. Katja König, B. Sc.
18. Alenka Lenart, B. Sc.
19. Darja Pečko, B. Sc.
20. Matejka Podlogar, B. Sc.
21. Benjamin Podmiljšak, B. Sc.
22. Mojca Presečnik, B. Sc.
23. Katarina Rade, B. Sc.
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27. Kristina Žagar, B. Sc.

Technical officers
28. Sanja Fidler, B. Sc.
29. Medeja Gec, B. Sc.

Note:
** employed in industry

BIBLIOGRAPHY

Original Articles

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2. Jana Bezjak, Boštjan Jančar, Philippe Boullay, Aleksander Rečnik, Danilo Suvorov, "Hexagonal perovskite-type phases in the BaO-rich part of the $BaO - WO_3 - Nb_2O_5$ system", *J. Am. Ceram. Soc.*, issue 12, vol. 92, pp. 3022-3032, 2009.
3. Jana Bezjak, Aleksander Rečnik, Boštjan Jančar, Philippe Boullay, Ivana Radosavljević Evans, Danilo Suvorov, "High-temperature transmission electron microscopy and X-ray powder diffraction diffraction studies of polymorphic phase transitions in $Ba_4Nb_2O_9$", *J. Am. Ceram. Soc.*, vol. 92, no. 8, pp. 1806-1812, 2009.
4. Maja Buljan, Uroš Desnica, Goran Dražić, Mile Ivanda, Nikola Radić, Pavo Dubček, K. Salamon, Sigrid Bernstorff, Václav Holý, "The influence of deposition temperature on the correlation of Ge quantum dot positions in amorphous silica matrix", *Nanotechnology (Bristol)*, vol. 20, no. 8, pp. 085612-1-085612-6, 2009.
5. Maja Buljan, Uroš Desnica, Mile Ivanda, Nikola Radić, Pavo Dubček, Goran Dražić, K. Salamon, Sigrid Bernstorff, Václav Holý, "Formation of three-dimensional quantum-dot superlattices in amorphous systems: experiments and Monte Carlo simulations", *Phys. rev., B, Condens. matter mater. phys.*, vol. 79, no. 3, pp. 035310-1-035310-11, 2009.
6. Maja Buljan, Uroš Desnica, Nikola Radić, Goran Dražić, Zdeněk Matěj, Václav Valeš, Václav Holý, "Crystal structure of defect-containing semiconductor nanocrystals - an X-ray diffraction study", *J. Appl. Crystallogr.*, part =4, vol. 42, pp. 660-672, 2009.
7. Maja Buljan, Goran Dražić, (10 authors), "Formation of long-range ordered quantum dots arrays in amorphous matrix by ion beam irradiation", *Appl. phys. lett.*, vol. 95, no. 6, pp. 063104-1-063104-3, 2009.
8. Jui Chakraborty, Matjaž Mazaj, Renu Kapoor, S. Pavana Gouri, Nina Daneu, Mithlesh K. Sinha, Gopal Pande, Bebabrata Basu, "Bone-like growth of hydroxyapatite in the biomimetic coating of Ti-6Al-4V alloy pretreated with protein at 2523C", *J. mater. res.*, vol. 24, no. 6, pp. 2145-2153, 2009.
9. Janez Dolinšek, Matej Komelj, Peter Jeglič, Stanislav Vrtnik, Denis Stanić, P. Popčević, Jovica Ivkov, Ana Smontara, Zvonko Jagličić, Peter Gille, Yuri Grin, "Anisotropic magnetic and transport properties of orthorhombic $Al_{13}Co_4$", *Phys. rev., B, Condens. matter mater. phys.*, vol. 79, no. 18, pp. 184201-184201-12, 2009.
10. Nataša Drnovšek, Nina Daneu, Aleksander Rečnik, Matjaž Mazaj, Janez Kovač, Saša Novak, "Hydrothermal synthesis of a nanocrystalline anatase layer on Ti6Al4V implants", *Surf. coat. technol.*, vol. 203, no. 10/11, pp. 1462-1468, 2009.
11. Boštjan Erjavec, Robert Dominko, Polona Umek, Sašo Šturm, Albin Pintar, Miran Gaberščček, "Tailoring nanostructured TiO_2 for high power Li-ion batteries", In: *Selected papers presented at the 14th international meeting on lithium batteries: Tianjin, China, 22 -28 June 2008: IMLB-2008*, (Journal of power sources, Vol. 189, Issue 1, 2009), Lausanne, Elsevier, 2009, issue 1, vol. 189, pp. 869-874, 2009.
12. Andreja Gajović, Davor Gracin, Krunoslav Juraić, Jordi Sancho-Parramon, Miran Čeh, "Correlating Raman-spectroscopy and high-resolution transmission-electron-microscopy studies of amorphous/nanocrystalline multilayered silicon thin films", *Thin solid films*, vol. 517, no. 18, pp. 5453-5458, 2009.
13. J. Honolka, Matej Komelj, (19 authors), "Complex magnetic phase in submonolayer Fe stripes on Pt(997)", *Phys. rev., B, Condens. matter mater. phys.*, vol. 79, no. 10, pp. 104430-1-104430-7, 2009.
14. Mersida Janeva Azdejković, Johannes Teun van Elteren, Kristina Žužek Rožman, Radojko Jaćimović, Evangelia Sarantopoulou, Spomenka Kobe, Alciviadis-Constantinos Cefalas, "Dual purpose laser ablation-inductively coupled plasma mass spectrometry for pulsed laser deposition and diagnostics of thin film fabrication: preliminary study", *Talanta (Oxford)*, vol. 79, no. 3, pp. 583-589, 2009.
15. Jakob Koenig, Matjaž Spreitzer, Boštjan Jančar, Danilo Suvorov, Zoran Samardžija, Arkadije Popović, "The thermal decomposition of $K_{0.5}Bi_{0.5}TiO_3$ ceramics", *J. Eur. Ceram. Soc.*, pp. 1695-1701, 2009.
16. Katja Koenig, Saša Novak, Aljaž Iveković, Katja Rade, Decheng Meng, Aldo R. Boccaccini, Spomenka Kobe, "Fabrication of CNT-SiC/SiC composites by electrophoretic deposition", In: *Proceedings of 3rd International Conference on Electrophoretic Deposition: Fundamentals and applications, October 5th- 9th, 2008, Awaji Japan*, (Journal of the european ceramic society, vol. 30, no. 5, 2009), Aldo R. Boccaccini, ed., Barking, Elsevier, 2009, vol. 30, no. 5, pp. 1067-1210, 2009.
17. Matej Komelj, J. Ivkov, Ana Smontara, P. Gille, Peter Jeglič, Janez Dolinšek, "Origin of the Hall-coefficient anisotropy in the Y-Al-Ni-Co periodic approximant to the decagonal phase", *Solid state commun.*, vol. 149, no. 13/14, pp. 515-518, 2009.
18. Manca Logar, Boštjan Jančar, Aleksander Rečnik, Danilo Suvorov, "Controlled synthesis of pure and doped ZnS nanoparticles in weak polyion assemblies: growth characteristics and fluorescence properties", *Nanotechnology (Bristol)*, vol. 20, no. 27, pp. 275601-1-275601-11, 2009.
19. Boštjan Markoli, Paul J. McGuiness, Benjamin Podmiljšak, Irena Škulj, Spomenka Kobe, "The synthesis of a magneto-caloric $Gd_5(GeSi)_4$ alloy using arc melting procedure", *RMZ-mater. geoenviron.*, vol. 56, no. 1, pp. 1-8, 2009.
20. Matjaž Mazaj, Wesley J.J. Stevens, Nataša Zabukovec Logar, Alenka Ristić, Nataša Novak Tušar, Iztok Arčon, Nina Daneu, Vera Meynen, Pegie Cool, Etienne F. Vansant, Venčeslav Kaučič, "Synthesis and structural investigations on aluminium-free Ti-Beta/SBA-15 composite", *Microporous and mesoporous materials*, vol. 117, no. 1/2, pp. 458-465, 2009.
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30. Aleksander Rečnik, Igor Dolinar, Uroš Herlec, Ivo Štrucl, Suzana Fajmut Štrucl, "Weltfundstellen: Die Blei- und Zinkerz-Lagerstätte Mežica in Slowenien", *Miner.-Welt*, vol. 20, no. 6, pp. 40-83, 2009.
31. Zoran Samardžija, "Mejne površine v kompozitih", *Vakuumist*, vol. 29, no. 1/2, pp. 9-22, 2009.
32. Zoran Samardžija, Kristina Žužek Rožman, Spomenka Kobe, "Determination of the composition of Co-Pt thin films with quantitative electron-probe microanalysis", *Mater. charact.*, vol. 60, no. 11, pp. 1241-1247, 2009.
33. Evangelia Sarantopoulou, Zoe Kollia, Alciviadis-Constantinos Cefalas, Ageliki Elina Siokou, Panagiotis Argitis, Vassilios Bellas, Spomenka Kobe, "Surface modification of polyhedral oligomeric silsesquioxane block copolymer films by 157 nm laser light", *J. appl. phys.*, vol. 105, no. 11, pp. 114305-1-114305-11, 2009.
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35. Sašo Šturm, Miran Čeh, "Atomic-scale structural and compositional analyses of Ruddlesden-Popper planar faults in AO-excess $SrTiO_3$ ($A = Sr^{2+}$, Ca^{2+}, Ba^{2+}) ceramics", *J. mater. res.*, vol. 24, no. 8, pp. 2596-2604, 2009.
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40. Kristina Žužek Rožman, Sašo Šturm, Paul J. McGuiness, Spomenka Kobe, "Hard magnetic Co-Pt-based nanotubes, produced via direct electroplating", In: *Proceedings of the INTERMAG 2009, IEEE International Magnetics Conference, May 4-8 2009, Sacramento, California*, (IEEE transactions on magnetics, vol. 45, no. 10, 2009), New York, Institute of Electrical and Electronics Engineers, 2009, vol. 45, no. 10, pp. 4413-4416, 2009.
41. Kristina Žužek Rožman, Sašo Šturm, Zoran Samardžija, Paul J. McGuiness, Spomenka Kobe, "The structure, composition and magnetic properties of direct-plated fcc Co-Pt-based tubular nanostructures", *Mater. chem. phys.*, vol. 118, no. 1, pp. 105-110, 2009.

Review Articles and Chapters in Books

1. Paul J. McGuiness, Andraž Kocjan, Spomenka Kobe, "Permanent magnets based on nanostructured intermetallic alloys", In: *Dekker encyclopedia of nanoscience and nanotechnology*, James A. Schwarz, Cristian I. Contescu, ed., Karol Putyera, ed., 2nd ed., Boca Raton, CRC Press, imprint of the Taylor & Francis Group, cop. 2009, pp. 3328-3335.

Published Conference Papers

Regular papers

1. Slavko Bernik, Ismail Özgür Özer, Matejka Podlogar, Ender Suvaci, "Texture ZnO-based ceramics - preparation and characterization", In: *Proceedings*, 45th International Conference on Microelectronics, Devices and Materials and the Workshop on Advanced Photovoltaic Devices and Technologies, September 9 - September 11, 2009, Postojna, Slovenia, Marko Topič, ed., Janez Krč, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2009, pp. 123-128.
2. Milan Bizjak, Ladislav Kosec, Borut Kosec, Marko Šuler, Blaž Karpe, Goran Dražić, "Microstructures of rapidly solidified Cu-Fe-Ti-C alloys", In: *Innovative materials and advanced concepts of metal casting production: proceedings book*, 9th International Foundrymen Conference, Opatija, June 18-19, 2009, Faruk Unkić, ed., Sisak, Faculty of Metallurgy, 2009, 4 pp.
3. Goran Dražić, Evangelia Sarantopoulou, Zoe Kollia, Alciviadis-Constantinos Cefalas, Spomenka Kobe, "Determination of oxygen content in pulsed laser deposited InN thin films with analytical electron microscopy", In: *Microscopy and Microanalysis 2009: proceedings*, (Microscopy and microanalysis, vol. 15, suppl. 2, 2009), 67th Annual Meeting of Microscopy Society [of] America, 43rd Annual Meeting [of] Microbeam Analysis Society, 42nd Annual Meeting [of] International Metallographic Society, Richmond, Virginia, USA, July 26-30, 2009, L. N. Brewer, ed., Cambridge, Cambridge University Press, 2009, vol. 15, suppl. 2, pp. 1316-1317, 2009.
4. Medeja Gec, Kristina Žagar, B. Bußmann, P. A. van Aken, Miran Čeh, "Preparation of nanotubes for cross-sectional TEM/STEM observation", In: *MC 2009. Vol. 1, Instrumentation and methodology*, Microscopy Conference, Graz, Austria, 30 August - 4 September 2009, Gerald Kothleitner, ed., Manfred Leisch, ed., Graz, Verlag der Technischen Universität, 2009, pp. 245-246.
5. Aljaž Iveković, Katja Koenig, Saša Novak, Goran Dražić, "Investigation of thermal conductivity in SiC_f/SiC composites for fusion application", V: *Proceedings*, International Conference Nuclear Energy for New Europe 2009, Bled, Slovenia, September 14-17, Leon Cizelj, ed., Boštjan Končar, ed., Matjaž Leskovar, ed., Ljubljana, Nuclear Society of Slovenia, 2009, 8 pp.
6. Matejka Podlogar, Slavko Bernik, Gurkan Yilmazoglu, Ismail Özgür Özer, Ender Suvaci, "Synthesis of rod-like ZnO by hydrothermal method", In: *Proceedings*, 45th International Conference on Microelectronics, Devices and Materials and the Workshop on Advanced Photovoltaic Devices and Technologies, September 9 - September 11, 2009, Postojna, Slovenia, Marko Topič, ed., Janez Krč, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2009, pp. 129-132.
7. B. Raskova, Sašo Šturm, (11 authors), "EELS measurements and Ab-initio calculations of the N-K edge in TiN/VN films deposited on MgO substrates", In: *MC 2009. Vol. 3, Materials Science*, Microscopy

Conference, Graz, Austria, 30 August - 4 September 2009, Werner Grogger, ed., Ferdinand Hofer, ed., Peter Pölt, ed., Graz, Verlag der Technischen Universität, 2009, pp. 285-286.
8. Zoran Samardžija, Kristina Žužek Rožman, Spomenka Kobe, "Quantitative EPMA of electrodeposited thin Co-Pt films: assessment of reliability and accuracy", In: *MC 2009. Vol. 1, Instrumentation and methodology*, Microscopy Conference, Graz, Austria, 30 August - 4 September 2009, Gerald Kothleitner, ed., Manfred Leisch, ed., Graz, Verlag der Technischen Universität, 2009, pp. 209-210.
9. Luka Snoj, Saša Novak, Igor Lengar, Melita Lenošek, "Promotion of fusion in Slovenia: current activities and future chalenges", In: *Proceedings*, International Conference Nuclear Energy for New Europe 2009, Bled, Slovenia, September 14-17, Leon Cizelj, ed., Boštjan Končar, ed., Matjaž Leskovar, ed., Ljubljana, Nuclear Society of Slovenia, 2009, 6 pp.
10. Sašo Šturm, Mehmet A. Gulgun, "Y segregation behavior controlled by the transient precipitation in saturated Y-doped alumina", In: *MC 2009. Vol. 3, Materials Science*, Microscopy Conference, Graz, Austria, 30 August - 4 September 2009, Werner Grogger, ed., Ferdinand Hofer, ed., Peter Pölt, ed., Graz, Verlag der Technischen Universität, 2009, pp. 279-280.
11. Dejan Verhovšek, Kristina Žagar, Miran Čeh, "The synthesis and characterization of rutile titanium oxide nanoparticles", In: *MC 2009. Vol. 3, Materials Science*, Microscopy Conference, Graz, Austria, 30 August - 4 September 2009, Werner Grogger, ed., Ferdinand Hofer, ed., Peter Pölt, ed., Graz, Verlag der Technischen Universität, 2009, pp. 127-128.
12. Kristina Žagar, Miran Čeh, "Synthesis and characterization of $SrTiO_3$ nanotubes", In: *MC 2009. Vol. 3, Materials Science*, Microscopy Conference, Graz, Austria, 30 August - 4 September 2009, Werner Grogger, ed., Ferdinand Hofer, ed., Peter Pölt, ed., Graz, Verlag der Technischen Universität, 2009, pp. 65-66.

TEXTBOOKS AND LECTURE NOTES

1. Miran Čeh, *Scanning electron microscopy and electron probe microanalysis: lecture notes 2008/2009*, Ljubljana, Jožef Stefan International Postgraduate School, 2009.

THESES

Ph. D. Thesis

1. Andraž Kocjan, *Hydrogen absorption in Ti-Zr-Ni alloys: doctoral dissertation*, Ljubljana, [A. Kocjan], 2009.

B. Sc. Thesis

1. Darja Pečko, *Electrochemical synthesis and characterization of iron-palladium magnetic thin films: undergraduate thesis*, Ljubljana, [D. Pečko], 2009.

PATENT APPLICATIONS

1. Dejan Verhovšek, Tomi Gominšek, Miran Čeh, Pavel Blagotinšek, Sašo Šturm, Kristina Žagar, *Nanodelci anatasa in postopek sinteze za pridobivanje nanodelcev anatasa: patent application P-200900341*, Ljubljana, Urad RS za intelektualno lastnino, 14 Nov. 2009.
2. Dejan Verhovšek, Tatjana Rožman, Miran Čeh, Pavel Blagotinšek, Sašo Šturm, Kristina Žagar, *Nanodelci rutila in postopek sinteze za pridobivanje nanodelcev: patent application P-200900340*, Ljubljana, Urad RS za intelektualno lastnino, 14 Nov. 2009.