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

In the field of **intermetallic alloys** we continued our research on electrodeposition as a preparation method for nanostructures. Fe-Pd and Co-Pt nanostructures were deposited in high-aspect-ratio alumina or polycarbonate templates. The reactions of Pd and Fe were investigated using cyclovoltametry, where Pd was shown to be irreversible, while Fe deposition was found to overlap with hydrogen evolution. Due to the overall mass-transport-limited deposition, which is characteristic for high-aspect-ratio templates, closely packed $Fe_{50}Pd_{50}$ nanowires were deposited via pulse plating. Via post-annealing processing, which induced the ordering into the tetragonal phase having high a magnetocrystalline anisotropy, the coercivity was significantly improved up to 120 kA/m. In the frame of an EU MNT-ERA.Net project, $Fe_{70}Pd_{30}$ nanotubes and nanowires were successfully synthesised for filtration purposes and in the frame of a national project (together with the National Institute of Chemistry, Slovenia) for the purposes of targeted drug delivery. The magnetization reversal behaviour in ferromagnetic nanotubes (Fe-Pd and Co-Pt) was investigated using angular-dependence measurements and magnetic force microscopy, which showed circumferential magnetization behaviour, which is stable at small applied field angles and coherent rotation stable at higher angles. The magnetization behaviour was also found to depend on the tube-wall thickness, where it was shown that curling is dominant in thin magnetic nanotubes.

We continued with studies on **hollow metallic nanoparticles** produced by PLD in a nitrogen atmosphere, since this is becoming an area of high potential for future applications in theranostics. These hollow nanospheres were successfully produced from CoPt, Fe, Fe(Sm,Ta) and Al targets.

We have looked at the effects of hydrogen and temperature on the magnetic and structural changes in Nd–Fe–Al alloys with compositions close to $Nd_{60}Fe_{30}Al_{10}$, using vibrating-sample magnetometry, x-ray diffraction and transmission electron microscopy. At approximately 30 bars and 100°C the material absorbs about 0.6 weight percent of hydrogen. As a result of this hydrogen absorption the coercive field decreases significantly, i.e., from 3750 Oe before to 120 Oe after the hydrogenation. We have used the strong-domain-wall-pinning model to explain the coercive field and its drop as a result of the hydrogen absorption. This model can be used to describe the material in the temperature range 250–450 K before hydrogenation for a domain-wall width of 7 nm. After hydrogenation the material displays soft-magnetic behaviour and the possible origins of this are still the subject of our investigations. Our results have demonstrated, once again, the important role that hydrogen can play in modifying the structure and properties of rare-earth–transition-metal-based permanent-magnet materials.

The grain-boundary diffusion process was used to enhance the coercivity of commercially available **Nd-Fe-B sintered magnets.** By using electrophoretic deposition (EPD) of DyF_3 or TbF_3 we achieved a spectacular 30% increase in coercivity, without any significant decrease in the remanence. With EPD it is also possible to tailor the coercivities to some extent: by varying the thickness of the coating we are able to tailor the coercivity of the magnet. We successfully performed WDS analyses on Nd-Fe-B magnets doped with Tb (the so-called core-shell structure). The thickness of the Tb-rich shell varied

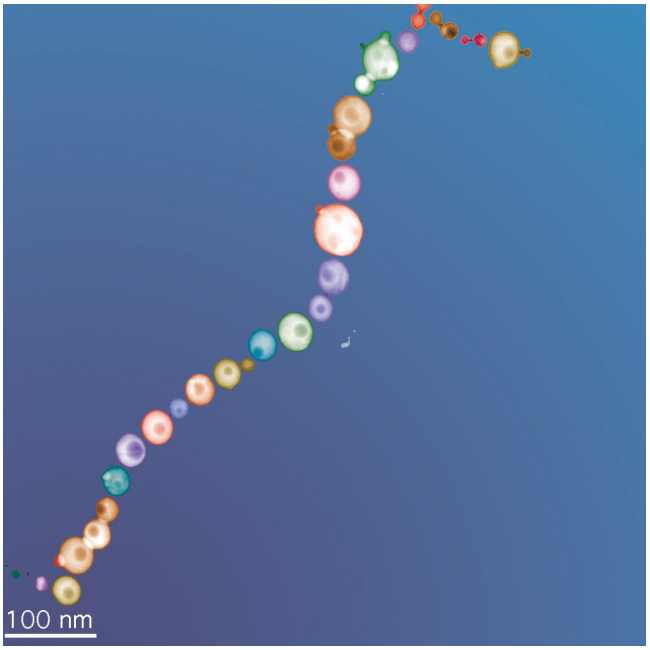

Figure 1: Necklace formed of hollow, CoPt-based nanospheres: potential application in magnetically and photothermally active nanoparticles for a tuneable drug-delivery and controlled drug-release system.

We have proven and systematically measured the nitrogen gas pressure within individual Al-based spheres. The nitrogen pressure ranged between 200 and 600 bars and was generally increasing by decreasing the volume of the void. This is in accordance with the equilibrium gas pressure that would form in a bubble in an Al melt when considering the corresponding surface energy.

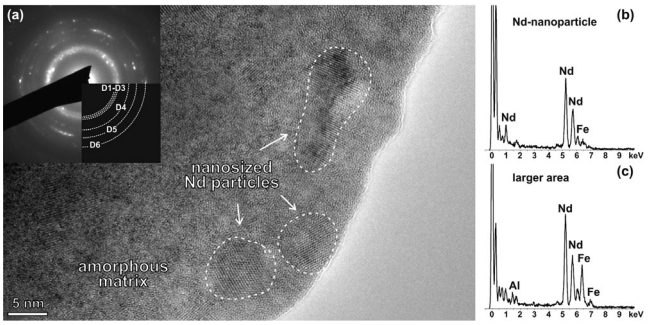

Figure 2 A: High-resolution micrograph of the as-cast sample reveals that it is composed of crystalline nanoparticles embedded in a amorphous matrix. (a) According to the SAED pattern, the nanocrystallites are hexagonal neodymium with the following interplanar distances D1=3.116 Å, D2=2.914 Å, D3=2.760 Å, D4=2.126 Å, D5=1.835 Å, D6=1.639 Å (b) EDS of the selected Nd nanoparticles and (c) EDS from a larger area.

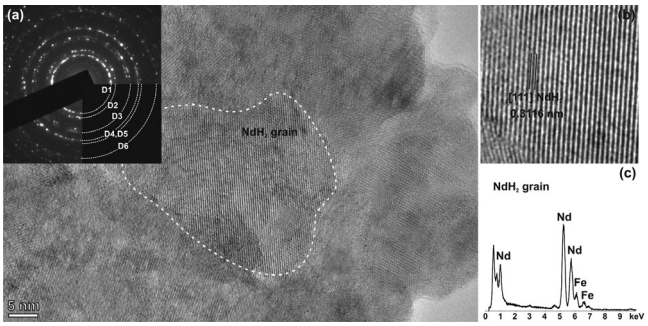

Figure 2 B: High-resolution TEM micrograph of the hydrogenated sample reveals that the sample contains more crystalline material and less amorphous matrix than the as-cast sample. (a) SAED reveals that the crystalline particles are the Nd_2H_3 phase with the corresponding planar distances D1=3.132 Å, D2=2.717 Å, D3= 1.916 Å, D4=1.637 Å, D5=1.566 Å and D6=1.356 Å. (b) Enlarged image of the [111] planes in the Nd_2H_5 nanoparticle. (c) EDS from the Nd_2H_5 grain.

With a sophisticated thermal treatment we successfully influenced the final microstructure and achieved both goals. If the microstructure is changed in such a way that we get a finely dispersed secondary phase in the magnetocaloric matrix phase, the structural transformation, which is responsible for the high hysteresis losses, occurs at higher magnetic fields. By using low magnetic fields, this effect can be avoided.

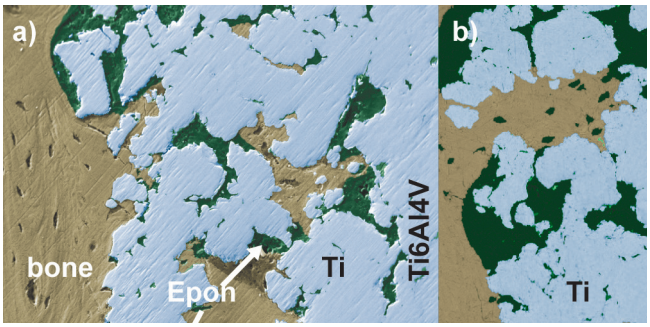

Figure 3: The bone grew deeper into the porous titanium layer on the implant surface with a bio-active glass coating (a) than in the case without it (b)

from about 2 μm near the edge of the magnet down to a few tens of nm in its inner part. Quantitative, sub-micrometre-scale EDS and WDS analyses confirmed that upon diffusion the Tb atoms substitute for the Nd atoms in the $Nd_2Fe_{14}B$ matrix phase and the reaction phase $(Nd_xTb_{1-x})_2Fe_{14}B$ is formed, with the equilibrium Tb concentration being equal to x = 0.5.

We continued our research on the **magnetocaloric effect** of intermetallic alloys and achieved a **breakthrough enhancement of their refrigerating capacity**. $Gd_5Si_2Ge_2$ known as material with a giant magnetocaloric effect has a problem of high hysteresis losses, which has been successfully reduced by adding a fourth element, usually iron, but with the consequence of a reduction of the magnetocaloric effect itself. As a result the refrigerant capacity was only moderately improved. Our goal was to reduce the hysteresis losses and simultaneously keep the high magnetocaloric effect.

In the field of **quasicrystals** we have shown that the tetragonal σ phase and the hexagonal (*hex*) phase in the Mn-Si-V(Cr) transition-metal-alloy systems are stable approximant phases of a dodecagonal (12-fold) quasicrystal that can be prepared in bulk quantities. We have synthesized samples of the σ and *hex* phases of composition $Mn_{76}Si_{18}Cr_6$ and determined their magnetic properties. In the σ-$Mn_{76}Si_{18}Cr_6$, a spin-freezing transition to a canonical spin-glass phase was detected below $T_f \approx 8$ K, characterized by a maximum in the zero-field-cooled susceptibility, a frequency-dependent cusp in the ac susceptibility, $M(H)$ hysteresis, and ultra-slow time decay of the thermo-remanent magnetization. In contrast, no spin-glass transition was observed in the *hex*-$Mn_{76}Si_{18}Cr_6$ phase down to the lowest investigated temperature of 2 K. The analysis of the susceptibility has shown that the coupling of spins in both phases is antiferromagnetic (AFM), but the coupling strength is considerably stronger in the σ phase. In both investigated samples, tiny Mn_3O_4 inclusions that undergo a transition to a ferrimagnetic phase at $T_C \approx 42$ K were detected by EDS and in the magnetic signal. The σ phase was obtained by water quenching of the arc-melted precursors, which were heat-treated for 8 days at 1100°C in a sealed silica tube, whereas to get *hex* phase heat treatment was conducted at 800°C.

The computer modelling was focused on diamond-like carbon (DLC) by performing calculations, that are based on the density-functional theory. A very important application of this study was in tribology, whereas the most important achievement was the investigation of the appearance of magnetism due to the doping with chromium atoms. The experimental results demonstrated the presence of magnetism in chromium-doped, diamond-like carbon. The ab-initio simulations revealed that an external strain due to the substrate is required in order to observe this phenomenon.

In the final year of the Meddelcoat project (FP6, IP-SME), we were mainly engaged in evaluation of the success of the developed **bioactive coatings on metal implants** with a porous surface. In collaboration with the company Helipro d.o.o. we performed extensive metallographic, stereological and histological analysis of the samples tested *in vivo*. Two of the coatings prepared at JSI, i.e., anatase and bioactive glass, revealed a significant enhancement of osseointegration in comparison with the samples without coating or with differently prepared coatings. The research of bioactive glass was also a topic of a bilateral project with the Ruđer Bošković Institute in Zagreb, an informal collaboration with Educell d.o.o., as well as of the COST action Namabio that is focused on the development of bioactive scaffolds for stem cells. The titania coatings, in particular their antibacterial properties, remained in our focus via the FP7-ITN project BioTiNet.

In 2011 we strengthened our collaboration with the National Institute for Biology, NIB. The main topic has been a study of **potential health hazard of free titania nanoparticles**, which is lately drawing a lot of attention in the literature. We prepared a comprehensive literature survey (published in

J. Radiol.Oncol.) and we collaborated in investigations of their toxicity by characterising various commercial TiO_2 powders. In the journals Nanotoxicology and J. Hazardous Materials we reported that some powders with particles larger than nanosized may also represent a health risk, and in particular UV-irradiated nanoparticles. In addition, an **advantageous cell interaction with SiC-based ceramics** has been also confirmed in collaboration with NIB.

Within the European fusion programme in which we have already collaborated for seven years, the most important result is the optimisation of the SITE-P process developed in our laboratory. The process enables the fabrication of 3-D SiC_f/SiC composites for the first-wall blanket in future fusion-power plants. The composite samples analysed at NRG in Petten exhibited high thermal conductivity in the temperature range from 25 °C to 1000 °C that meets the requirement for the material. We also collaborated in other activities of the Slovenian Fusion Association, such as the organisation of the itinerant Fusion Expo and other public-information activities within the European network.

Perovskite $BaTiO_3$ nanorods and **$SrTiO_3$ nanotubes** were synthesized via sol-gel electrophoretic deposition into anodic aluminum oxide (AAO) membranes. In the article "Characterization of Individual Barium Titanate Nanorods and Their Assessment as Building-Blocks of New Circuit Architectures" published in Nanotechnology we reported on the integration of individual $BaTiO_3$ nanorods into simple circuit architectures. Polycrystalline $BaTiO_3$ nanorods were synthesized by the electrophoretic deposition (EPD) of a barium titanate sol into aluminium oxide (AAO) templates and subsequent annealing. TEM observations revealed the presence of slabs of hexagonal polymorphs intergrown within cubic grains, resulting from the local reducing atmosphere during the thermal treatment.

In the field of **photovoltaics** we assembled and tested the DSSC (dye-sensitized solar cells) solar cells. A porous thin film of anatase TiO_2 on a rigid electrode was prepared by the doctor-blade method. For the manufacturing of the DSSC solar cells on flexible substrates we determined the optimum processing parameters for the preparation of a thin layer of 2-D ordered TiO_2 nanotubes on the Ti foil by anodization of the Ti metal foil.

The use of **transparent and conductive films** (TCFs) in technologies of liquid crystal and plasma displays, touch panels, organic light-emitting diodes and solar cells is dominated by indium-tin-oxide (ITO). The high price of In emphasizes the strong need for the development of cheaper alternatives, such as ZnO-based TFSs. Using low-temperature hydrothermal synthesis at 90°C we prepared on the glass substrates, from a water solution of Zn-nitrate and with the addition of Na-citrate, smooth, dense and highly (0001)-oriented polycrystalline ZnO films with an optical transparency of 82% and for undoped films a low resistivity of about 80 Ωcm. We explained the formation of a highly textured polycrystalline film by a spatially confined oriented growth (SCOG) mechanism, which requires an appropriate nucleation layer on the glass substrate.

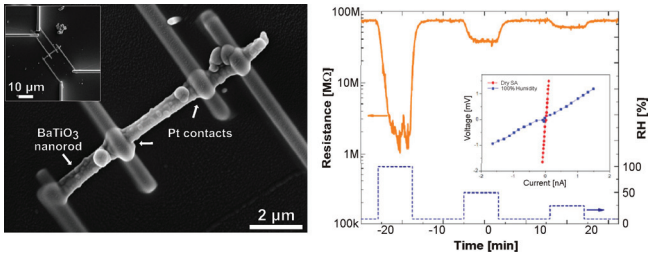

Figure 4: (a) Detail of a $BaTiO_3$ nanorod contacted with FIB nanolithography in a 4-probe configuration. The inset in the upper left corner shows a low-magnification image of the same device. (b) Sensing response of a $BaTiO_3$ nanorod towards pulses of 100, 50 and 25 % of relative humidity (RH) measured at room temperature. Synthetic air was used as the carrier gas. The inset shows I-V curves obtained in dry and humid (100 % RH) air. A sharp and reversible modulation of the electrical response was observed.

Research on oxide thermoelectric materials was focused on the synthesis of a p-type $Ca_3Co_4O_9$ compound using an alternative approach of mechano-chemical alloying. The development and construction of the system for thermoelectric characterization of materials up to 700°C reached its final stage and in the first months of 2012 we are expecting to start with the test measurements.

We started with the development of the **thick-film varistors** on Al_2O_3 substrates. Inks for screen printing were prepared and the influence of the varistor powder composition on the ink and firing temperature on the formation of the thick film, its interactions with the substrate and its current-voltage (I-U) characteristics were studied.

We continued the study of the synthesis of titania particles in anatase and rutile crystal form using sol-gel and hydrothermal methods. The influence of process parameters on the size, morphology and photocatalytic efficiency of the particles was studied. The nucleation and growth of anatase particles to the specific bi-pyramid morphologies was explained. Due to the difference in the energies of certain crystal planes and the non-equilibrium conditions the growth of starting block-like particles continued through asymmetric rod-like particles, elongated in one of the <101> directions. The particle morphologies were reconstructed from HRTEM images. We continued with a study of the nucleation and crystallization of ZnO nanoparticles to be used as UV absorbers. The crystallization of iron oxide nano-rings was studied by TEM and microanalytical techniques. **The self-assembly of Ge quantum dots** in an amorphous silica matrix after the high-energy ions' irradiation was investigated using electron microscopy and microanalysis. Together with colleagues from Croatia, Italy and the Czech Republic we published a series of articles explaining self-organization. In collaboration with scientists

Electrical measurements performed on individual $BaTiO_3$ nanorods revealed resistivity values between 10 and 100 ohm·cm, which is in good agreement with typical values reported in the past for oxygen-deficient barium titanate films. Consequently, the presence of oxygen vacancies in their structure was indirectly validated. Some of these nanorods were tested as proof-of-concept humidity sensors. They showed reproducible responses towards different moisture concentrations, demonstrating that individual $BaTiO_3$ nanorods may be integrated in complex circuit architectures with functional capacities.

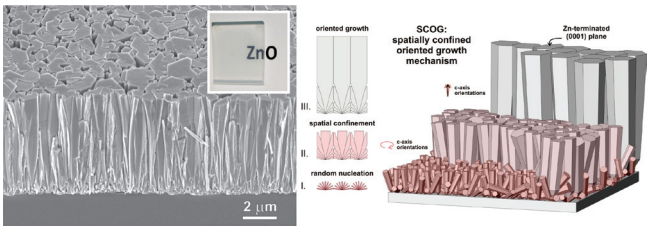

Figure 5: a) ZnO film on glass prepared by low-temperature hydrothermal synthesis at 90°C from a water solution of Zn-nitrate with the addition of Na-citrate. The inset top-right shows the high optical transparency of the film. b) Schematic presentation of the spatially confined oriented growth (SCOG) mechanism, which in the process of hydrothermal synthesis enables the growth of a dense and highly (0001) textured ZnO film from the nucleation layer on the glass substrate.

In collaboration with the VARSI company two projects were successfully completed. The development of surge protections for solar panels and wind-turbine generators required an improvement to the dc stability of the ZnO-based varistors. Within the project Novel innovative systems for electrical equipment, complex-shaped tubular or oval hollow varistors were developed using slip-casting technology.

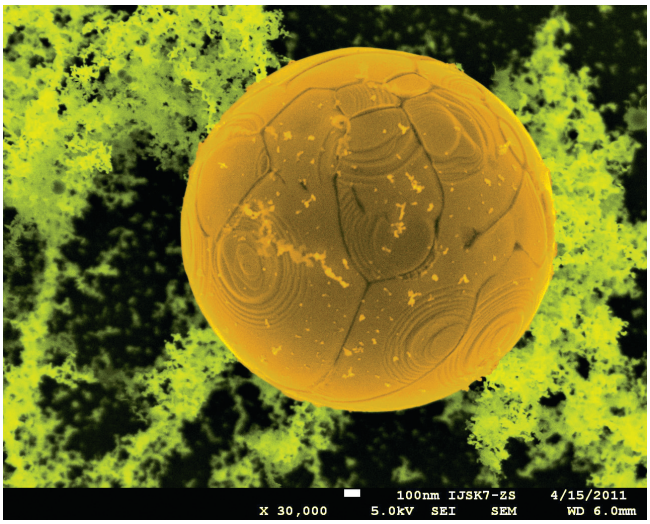

Figure 6: FEGSEM image of solidified 2-μm-sized Au droplet among the Au nano-particles deposited by pulsed-laser deposition - PLD method (F2 laser; λ = 157 nm).

EDS and WDS methods were optimized and improved for the nanometre-scale compositional analyses by the implementation of low-voltage microscopy and X-ray spectroscopic measurements of low-energy spectral lines with energies below 5 keV.

from Portugal the influence of the addition of carbon nano-tubes to TiO_2 on the **catalytic properties** of the material was studied.

We have investigated the **influence of special boundaries in crystal growth.** They are known to introduce an abrupt structural and chemical anisotropy, which is readily reflected in an unusual microstructure evolution, whereas their local structure affects the physical properties of polycrystalline materials. These effects can be exploited to tailor the electronic and optical properties of materials. In the non-centrosymmetric structure of ZnO, inversion boundaries (IBs) are the most common type of planar faults that is triggered by the addition of the specific IB-forming dopants (Sb_2O_3, SnO_2, TiO_2). Their local structure was analysed by conventional TEM techniques and some new methods were developed to resolve their crystallography and atomic-scale chemistry. By knowing the local crystal chemistry of IBs we were able to design experiments to identify their formation mechanism. IBs nucleate in the early stage of grain growth as a dopant-rich topotaxial 2D reaction product on Zn-terminated surfaces of ZnO grains. Soon after their nucleation, ZnO is epitaxially grown on the inherent 2D phase in an inverted orientation, which effectively starts to dictate the anisotropic growth of the infected crystallite. In a very short time the grains with IBs dominate the entire microstructure via an *IB-induced exaggerated grain growth* mechanism. This phenomenon was used to design the physical properties of ZnO-based varistor ceramics, whereas the bottom-up approach demonstrated here provides the basic tool for the microstructural engineering of functional materials in virtually any system that is prone to the formation of special boundaries.

We studied the twin-boundary formation of Japanese twins in natural quartz. TEM studies confirmed that the twin boundary is in accordance with the Japan twin law; however, the appearance of the boundary is changing rapidly across the twinned crystal, suggesting that the twin formation is associated only with the early nucleation stage of the crystal growth.

For the reliable characterization of various materials on the micro- and nanometre scales we have applied advanced methods of high-resolution scanning electron microscopy (FEGSEM) and energy-dispersive and wavelength-dispersive X-ray spectroscopies, EDS and WDS.

Using these methods we have characterized the morphology and the chemical composition of various nano-materials, such as FePd and CoPt nanorods and thin films, TiO_2 and ZnO nanoparticles and submicrometer-sized reaction phases in the Nd-Fe-B sintered magnets doped with Tb. The obtained results allowed us to explain the influence of the process parameters of production and/or the modification of the investigated materials on their physical and chemical properties.

In the field of analytical electron microscopy we were also involved in establishing the TEM analytical procedure for reliable, quantitative compositional analysis of perovskite ceramics that contain volatile alkaline compounds. To discriminate the material-specific composition from the artefacts introduced during the EDXS/TEM analyses, the effects of radiation damage and the absorption of the characteristic X-ray lines were studied in detail by combined EDXS and EELS analysis.

One of the important research areas of the group is the implementation and development of various electron microscopy analytical techniques within the existing EU project ESTEEM, such as electron energy-loss spectroscopy (EELS), high-resolution scanning transmission electron microscopy (STEM, HAADF-STEM) electron holography and the mechanical preparation of the TEM samples. The research group is additionally strongly involved in managing of the Center for Electron Microscopy within the frame of the national infrastructure Center for Microstructural and Surface Analysis. The implementation of various electron microscopy analytical techniques and the possibility for researchers to access the research infrastructure for electron microscopy is of utmost importance for numerous research institutions,

industrial partners (Cinkarna Celje, SwatyComet, Hidria AET, Iskra Zaščite, Termoelektrarna Toplarna Ljubljana, ITW Metalflex, ZZZV Maribor, Kolektor), as well as for graduate and post-graduate education.

Some outstanding publications in the past year

1. S. Kobe, B. Podmiljšak, P. J. McGuiness and M. Komelj, CMAs as magnetocaloric materials, a chapter in the book Complex Metallic Aalloys: Fundamentals and Applications, Weinheim: Wiley-VCH, 2011
2. K. Žagar, F. Hernandez-Ramirez, J. D. Prades, J.R. Morante, A. Rečnik and M. Čeh. Characterization of individual barium titanate nanorods and their assessment as building blocks of new circuit architectures. *Nanotechnology (Bristol)*, 2011, vol. 22, no. 38, str. 385501-1-385501-6.
3. A. Ivekovič, G. Dražić, S. Novak, Densification of a SiC-matrix by electrophoretic deposition and polymer infiltration and pyrolysis process. *J. Eur. Ceram. Soc.*. [Print ed.], 2011, vol. 31, no. 5, str. 833-840, doi: 10.1016/j.jeurceramsoc.2010.11.021.
4. N. Daneu, A. Rečnik, S. Bernik, Grain-growth phenomena in ZnO ceramics in the presence of inversion boundaries, *J. Am. Ceram. Soc.*, 94 (5), (2011), 1619-1626
5. K. Žužek Rožman, D. Pečko, L. Suhodolčan, P.J. McGuiness, S. Kobe, Electrochemical syntheses of soft and hard magnetic $Fe_{50}Pd_{50}$-based nanotubes and their magnetic characterization. *J. alloys compd.*. [Print ed.], 2011, vol. 509, issue 2, str. 551-555, doi: 10.1016/j.jallcom.2010.09.108.
6. A. Kocjan, S. Kovačič, A. Gradišek, J. Kovač, P.J. McGuiness, T. Apih, J. Dolinšek, S. Kobe, Selective hydrogenation of Ti-Zr-Ni alloys. *Int. j. hydrogen energy*. [Print ed.], 2011, vol. 36, issue 4, str. 3056-3061, doi: 10.1016/j.ijhydene.2010.11.116.

Patents granted

1. Bioactive and photocatalytic coating on metal implants and a process of preparing thereof
   Saša Novak, Nataša Drnovšek
   SI23312 (A), Slovenian Intelectual Property Office, 19 March 2011.

Anatase nanoparticles and procedure for synthesis of anatase nanoparticles
   Dejan Verhovšek, Tomi Gominšek, Miran Čeh, Pavel Blagotinšek, Sašo Šturm, Kristina Žagar
   SI23219 (A), Slovenian Intelectual Property Office, 31 May 2011.

Rutile nanoparticles and procedure for synthesis of rutile nanoparticles
   Dejan Verhovšek, Tatjana Rožman, Miran Čeh, Pavel Blagotinšek, Sašo Šturm, Kristina Žagar
   SI23218 (A), Slovenian Intelectual Property Office, 31 May 2011.

Awards and appointments

1. Medeja Gec, Tea Toplišek, Goran Dražić: "Preparation of Sigma™ SiC fibres for TEM by tripod polishing and conventional ion milling"; a Poster Award for the best poster in Instrumentation and Methodology, MCM2011 - 10th Multinational Congress on Microscopy 2011, Urbino, Italy, 4–9 September 2011
2. Zoran Samardžija & Darko Makovec: "EPMA-WDS quantitative compositional analysis of barium titanate ceramics doped with cerium"; The Best Poster Award at the 12th European Workshop on Modern Developments and Applications in Microbeam Analysis – EMAS 2011, Angers, France, 15–19 May 2011
3. Marko Soderžnik, Paul McGuiness, Kristina Žužek Rožman, Spomenka Kobe: The best presentation among young researchers in the research field Nanomaterials and Nanotechnology, 19th Conference on Materials and Technology, Portorož, Slovenia, 22–23 November 2011. The title of the awarded presentation: Electrophoretic Deposition of DyF_3 on Nd-Fe-B Sintered Magnets

Organization of conferences, congress and meetings

1. 1st BioTiNet Workshop »Advanced Methods for Materials Characterization«, Ljubljana, Slovenia, 23–27 October 2011
2. Čím budú svietit' deti vašich detí, Fusion Maxi EXPO, Avion Shopping Park, Bratislava, Slovak Republic, 5 January – 18 February 2011 (co-organisation)
3. Fusion Energiequelle der Zukunft, Fusion EXPO Maxi, TU Wien, Vienna, Prechtlsaal, Austria, 1–10 March 2011 (co-organisation)
4. Énergie Fusion, Énergie du futur, Fusion EXPO Maxi, Palais de la musique et des congrès Pierre-Pflimlin, Strasbourg, France, 26 June– 2 July 2011 (co-organisation)

5. Fusion Expo at the Lowlands Music Festival 2011, Biddinghuizen, The Netherlands, 19–21 August 2011 (co-organisation)
6. Fusion show "Plasma's. Fusie! Energie?", Campus Drie Eiken, Antwerpen (Wilrijk), Belgum, 17–23 November 2011 (co-organisation)
7. 19th Conference on Materials and Technologies, Portorož, Slovenia, 22–23 November 2011 (co-organisation)
8. 10th Multinational Congress on Microscopy 2011 - MCM2011, Urbino, Italy, 5–9 September 2011 (membership in International Advisory Board)
9. C-MAC Days 2011, University of Liverpool, Liverpool, United Kingdom, 8–9 November 2011 (membership in Science Board and General Assembly in the European Integrated Center for the Development of New Metallic Alloys and Compounds (C-MAC))

INTERNATIONAL PROJECTS

1. Academic-Industrial Initial Training Network on Innovative Biocompatible Titanium-base Structures for Orthopaedics
   BioTiNet
   7. FP, 264635
   EC; Prof. Jürgen Eckert, Leibniz-Institut für Festkörper- und Werkstoffforschung, Dresden, Germany
   Prof. Spomenka Kobe, Asst. Prof. Saša Novak Krmpotič
2. Tailoring of Tribological Interfaces for Clean and Energy-Efficient Diesel and Gasoline Power Trains
   2020 INTERFACE
   7. FP, 234324, SCP8-GA-2009-234324
   EC; Jacqueline 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
3. Merging Atomistic and Continuum Analysis of Nanometer Length-scale Metal-oxide Systems for Energy and Catalysis Applications
   MACAN
   7. FP, 233484, NMP3-CA-2009-233484
   EC; Prof. Wayne Kaplan, Technion - Israel Institute of Technology, Haifa, Israel
   Asst. Prof. Aleksander Rečnik
4. Improving the Gender Diversity Management in Materials Research Institutions
   DIVERSITY
   7. FP, 230253
   EC; Dr. Oliver Gutfleisch, Leibniz-Institut für Festkörper- und Werkstoffforschung, Dresden, Germany
   Prof. Spomenka Kobe
5. Cooperation of Space NCPs as a Means to Optimise Services
   COSMOS
   7. FP, 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
6. Production of a Dense SIC-based Composite with Closed Porosity - 4.1.1.1.- FU
   EURATOM – MHEST
   7. FP - EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Asst. Prof. Goran Dražič
7. Optimisation of Thermal Conductivity of SIC Composite - 4.1.1.1.
   WP11-MAT-SiC/SiC-02-01/PS
   EURATOM – MHEST
   7. FP - EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Asst. Prof. Goran Dražič, Asst. Prof. Saša Novak Krmpotič
8. Definition of a Fabrication Route for an Optimised SiC-based Composite - 4.1.1.2.
   WP11-MAT-SiC/SiC-01-01-PS/MHEST
   EURATOM – MHEST
   7. FP - EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Asst. Prof. Saša Novak Krmpotič
9. Review R&D on Materials - 4.1.1.2.
   WP11-DAS-MAT-M03-01/MHEST/PS
   EURATOM – MHEST
   7. FP - EURATOM, Slovenian Fusion Association – SFA
   3211-08-000102, FU07-CT-2007-00065
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Asst. Prof. Saša Novak Krmpotič
10. Fusion Expo Support Action under EFDA Work Programme, Task Agreement WP10-PIN-FUSEX
    EURATOM - MHEST
    7. FP - EURATOM, Slovenian Fusion Association – SFA
    3211-08-000102, FU07-CT-2007-00065
    EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
    Asst. Prof. Saša Novak Krmpotič, Tomaž Skobe, B. Sc., Melita Lenošek Kavčič, B. Sc., Asst. Prof. Igor Lengar
11. Public Information; Research Unit - Administration and Services - RU-FU
    EURATOM – MHEST
    7. FP - EURATOM, Slovenian Fusion Association – SFA
    Annex 3, 3211-08-000102, FU07-CT-2007-00065
    EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
    Asst. Prof. Saša Novak Krmpotič, Prof. Milan Čerček
12. Multifunctional Bioresorbable Biocompatible Coatings with Biofilm Inhibition and Optimal Implant Fixation
    6. FP, MEDDELCOAT
    NMP3-CT-2006-026501
    EC; Prof. Jozef Vleugels, Katholieke Universiteit Leuven, Research & Development, Leuven, Belgium
    Asst. Prof. Saša Novak Krmpotič
13. Distributed European Infrastructure of Advanced Electron Microscopy for Nanoscience
    ESTEEM
    6. FP, 026019
    EC; Prof. Gustaaf Van Tendeloo, Universiteit Antwerpen, Antwerpen, Belgium
    Prof. Miran Čeh, Asst. Prof. Sašo Šturm
14. Hydrogen Impermeable Nano-material Coatings for Steels
    Hy-nano-IM
    MNT ERA NET
    Asst. Prof. Paul McGuiness
15. Novel Smart Filtration Media
    NSFM
    MNT-ERA-NET II
    Warsaw University of Technology (WUT), Warsaw, Poland
    Dr. Kristina Žužek Rožman
16. From Nano to Macro Biomaterials (Design, Processing, Characterization, Modelling) and Applications to Stem Cells Regenerative Orthopedic and Dental Medicine
    COST MP1005, NAMABIO
    EC; COST Office, Brussels, Belgium
    Asst. Prof. Saša Novak Krmpotič, Nataša Drnovšek, B. Sc.
17. Investigation of Electrical Mobility and Dielectric Relaxation of Bioactive Glass
    BI-HR/10-11-002
    Dr. Andrea Moguš-Milanković, Ruđer Bošković Institute, Zagreb, Croatia
    Asst. Prof. Saša Novak Krmpotič
18. Correlation of Structure and Properties of Nanostructured Perovskites
    BI-HR/10-11-027
    Dr. Andreja Gajović, Ruđer Bošković Institute, Zagreb, Croatia
    Asst. Prof. Sašo Šturm
19. 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
    Asst. Prof. Slavko Bernik
20. 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

21. Nanofabrication and Advanced Characterization of Funtionalised Materials
BI-PT/10-11-009
Dr. Adrian M. T. Silva, Laboratory of Catalaysis and Materials, Faculty of Engineering, University of Porto, Porto, Portugal
Asst. Prof. Goran Dražić
22. Electron Energy-Loss Spectroscopy of Boron Incorporation in Strontion Aluminate
BI-TR/11-13-007
Asst. Prof. Cleva Ow-Yang-Gülgün, Sabanci University, Faculty of Engineering and Natural Science, Tuzla, Istanbul, Turkey
Asst. Prof. Sašo Šturm
23. Investigation of High Temperature Reactions between Doped Perovskite Components in a Solid Oxide Fuel Cell
BI-TR/10-12-005
Asst. Prof. Mehmet Ali Gülgün, Sabanci University, Faculty of Engineering and Natural Science, Tuzla, Istanbul, Turkey
Prof. Miran Čeh

R & D GRANTS AND CONTRACTS

1. New metallic materials for thermal storage of digital information
Dr. Andraž Kocjan
2. Twinning, epitaxy and phase transformations in minerals
Asst. Prof. Nina Daneu
3. Near-net shape nanoparticle-reinforced polymer-composites for highly-loaded advanced mechanical components with superior tribological performance
Asst. Prof. Saša Novak Krmpotič
4. Electron microscopy and microanalysis of materials on submicrometer scale
Dr. Zoran Samardžija
5. Hydrothermal synthesis of strongly adhered TiO_2 photocatalytic coatings on metallic substrates
Asst. Prof. Goran Dražić
6. Novel functionalized nanomaterials for applications as nano- or biosensors/actuators/bioresponsive (carrier) systems
Dr. Kristina Žužek Rožman
7. Exploration and preservation of mineralogical heritage
Asst. Prof. Aleksander Rečnik
8. Microbial adhesion management on material surfaces
Asst. Prof. Goran Dražić
9. Physics and chemistry of interfaces of nanostructured metallic materials
Prof. Miran Čeh
10. High-coercivity Nd-Fe-B bonded magnets for automotive applications
Prof. Spomenka Kobe
11. Protected Permanent Magnets for Advanced High-Temperature Applications
Asst. Prof. Paul John Mcguiness
12. Materials and technologies for applications of ZnO-based thick-film varistors and oxide thermoelectrics
Asst. Prof. Slavko Bernik
13. Colour, absorption and protective nanolayer coatings for aluminium alloy
Prof. Dr. Miran Čeh (Dr. Peter Panjan)
14. Development of the model of the system for intelligent support of the selection of suitable powder material when developing sintered products
Asst. Prof. Saša Novak Krmpotič
15. Modification of TiO_2 nanoparticle surface: prevention of agglomeration and preservation of intrinsic properties
Asst. Prof. Aleksander Rečnik
16. Innovative production systems for vaccines and regenerative medicine
Asst. Prof. Aleksander Rečnik

RESEARCH PROGRAM

1. Nanostructured materials
Prof. Spomenka Kobe

NEW CONTRACTS

1. High-coercivity Nd-Fe-B bonded magnets for automotive applications
Kolektor Group, Vodenje in upravljanje družb d.o.o., Idrija
Prof. Spomenka Kobe
2. Protected permanent magnets for advanced high-temperature applications
MAGNETI, Ljubljana, Podjetje za proizvodnjo magnetnih materialov, d.d., Ljubljana
Asst. Prof. Paul McGuiness
3. Materials and technologies for applications of ZnO-based thick film varistors and oxide thermoelectrics
VARSI, podjetje za proizvodnjo varistorjev in sklopov, d.o.o., Ljubljana
Asst. Prof. Slavko Bernik
4. Materials and technologies for applications of ZnO-based thick film varistors and oxide thermoelectrics
KEKON keramični kondenzatorji, d.o.o., Žužemberk
Asst. Prof. Slavko Bernik
5. Nano varistor
RC eNeM Nanovaristor, Ljubljana
Asst. Prof. Slavko Bernik

MENTORING

Ph. D. Theses

1. Katja König, The production of advanced ceramic materials by electrophoretic deposition (mentor Spomenka Kobe; co-mentors Saša Novak Krmpotič, Aldo R. Boccaccini).
2. Tea Toplišek, Ceramic composites with long silicon-carbide fibers (mentor Spomenka Kobe).
3. Kristina Žagar, Synthesis and characterization of perovskite nanostructures (mentor Miran Čeh).

Bologna M. Sc.Thesis

1. Milena Zorko, Self-assembled structures based on monodisperse spherical silica particles (mentor Saša Novak Krmpotič; co-mentor Miran Gaberšček).

VISITORS FROM ABROAD

1. Dr Velimir Radmilović, National Center for Electron Microscopy, Lawrence Berkeley National Laboratory, University of California, Berkeley, USA, 20–21 January 2011
2. Dr Mehmet Ali Gülgün, Shalima Shawuti and Gulcan Corapcioglu, Sabanci University, Istanbul, Turkey, 17–24 February 2011
3. Prof. A. C. Cefalas, National Hellenic Research Foundation – HNRF, Athens, Greece, 17–19 February 2011
4. Dr Ulrike Wolf, Leibniz-Institut für Festkörper- und Werkstoffforschung - IFW, Dresden, Germany, 27 March – 15 April 2011
5. Prof. Norberto Roveri, Martina Lorenzetti, Alma Mater Studiorum, Università di Bologna, Lab. LEBSC, Bologna, Italy, 7–9 March 2011
6. Dr Aguar Pilar, European Commission, DG Research, Brusells, Belgum; Prof. Jef Vleugels, Prof. Omer Van Der Biest, Tina Mattheys, Annabel Braem, Bram Neirinck, Katholieke Universiteit Leuven, MTM, Leuven, Belgium; Prof. Jozef Anné and Lieve Van Mellaert, Katholieke Universiteit Leuven, CEMOL, Leuven, Belgium; Marko Gradišar, HELI PRO d. o. o., Lesce, Slovenia; Prof. Monika Willert-Porada and Dr Andreas Rosin, Universität Bayreuth, Bayreuth, Germany; Dr Marie-Françoise Harmand, Laboratoire d'Evaluation des Matériels Implantables – LEMI, Martillac, France; Jordi Garcia-Forgas, Peyer Fertigungstechnik AG, Waltenschwil, Switzerland; Dr Martin Erdtmann, HEMOTEQ GmbH, Würselen, Germany; Dr Paul Michelis, Institute of Mechanics of Materials and Geostructures – IMMG SA, Penteli, Greece; Prof. Michael Gasik, Helsinki University of Technology – HUT, Espoo, Finland; Dr Alessandro Facchini and Dr Michele Pressacco, LIMA-LTO S.P.A., Udine, Italy; Dario Pirovano, EUCOMED, Woluwe St. Pierre, Belgium; Matevž Gorenšek, EDUCELL, d.o.o., Ljubljana, Slovenia; 14–15 March 2011
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10. Muhammad Shahid Arshad, Royal Institute of Technology – KTH, Stockholm, Sweeden, 16–20 May 2011
11. Dr Maxime Feraille, Embassy of Republic of France, Ljubljana, Prof. Janez Kranjc, Faculty of Law, University of Ljubljana, Slovenia, 23 May 2011

12. Dr Mehmet Ali Gülgün, Dr Cleva Ow-Yang, Melike Mercan Yildizhan, Gulcan Corapcioglu and Guliz Inan, Sabanci University, Istanbul, Turkey, 7–14 August 2011
13. Milivoj Plodinec, Dipl. Eng. Phys., Institut Ruđer Bošković, Zagreb, Croatia, 15 October – 15 April 2012
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16. Radovan Bolko, Igor Draksler, Ludvik Kumar, Dr Boris Saje, Kolektor Group, Idrija, Slovenia, 14 November 2011
17. Dr Andreja Gajović, Rudjer Bošković Institute, Zagreb, Croatia, 14–18 November 2011
18. Dr Luisa Maria Pastrana Martinez, FEUP – Faculdade de Engenharia da Universidade do Porto, Porto, Portugal, 20–27 November 2011
19. Prof. Jean-Marie Dubois, Jean Lamour Institute, Nancy, France, 7–8 December 2011
20. Ricardo Segundo, FEUP – Faculdade de Engenharia da Universidade do Porto, Porto, Portugal, 26–30 December 2011
21. Dr Andreja Gajović, Rudjer Bošković Institute, Zagreb, Croatia, 26–30 December 2011

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35. Dr. Tea Toplišek
36. Dejan Verhovšek**
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38. Sanja Fidler, B. Sc.
39. Medeja Gec, B. Sc.

Note:
** postgraduate financed by industry

BIBLIOGRAPHY

Original Articles

1. Marcela Achimovičová, Peter Baláž, Juraj Ďurišin, Nina Daneu, Juraj Kováč, Alexander Šatka, Armin Feldhoff, Eberhard Gock, "Mechanochemical synthesis of nanocrystalline lead selenide: industrial approach", *Int. j. mater. res.*, vol. 102, no. 4, pp. 441-445, 2011.
2. Marcela Achimovičová, Klebson Lucenildo da Silva, Nina Daneu, Aleksander Rečnik, Sylvio Indris, Holger Hain, Marco Scheuermann, Horst Hahn, Vladimir Šepelák, "Structural and morphological study of mechanochemically synthesized tin diselenide", *J. mater. chem.*, vol. 21, issue 16, pp. 5873-5876, 2011.
3. Slavko Bernik, Matejka Podlogar, Nina Daneu, Aleksander Rečnik, "A novel approach to tailoring the microstructure and electrical characteristics of ZnO-based varistor ceramics via inversion-boundary (IB) induced grain growth", *Zašt. mater.*, vol. 52, no. 2, pp. 73-79, 2011.
4. Maja Buljan, I. Bogdanović-Radović, M. Karlušić, Uroš Desnica, Nikola Radić, Milko Jakšić, K. Salomon, Goran Dražić, Sigrid Bernstorff, Václav Holý, "Design of quantum dot lattices in amorphous matrices by ion beam irradiation", *Phys. rev., B, Condens. matter mater. phys.*, vol. 84, no. 15, pp. 155312-1-155312-8, 2011.
5. Jui Chakraborty, Nina Daneu, Aleksander Rečnik, Manjusha Chakraborty, Sudip Dasgupta, Jiten Ghosh, Somoshree Sengupta, Sujuta Mazumdar, Mithlesh Sinha, Debabrata Basu, "Stepwise formation of crystalline apatite in the biomimetic coating of surgical grade SS 316L substrate: a TEM analysis", *Journal of the Taiwan institute of chemical engineers*, vol. 42, no. 4, pp. 682-687, 2011.
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8. Andreja Gajović, Adrián M. T. Silva, Ricardo A. Sigundo, Sašo Šturm, Boštjan Jančar, Miran Čeh, "Tailoring the phase composition and morphology of Bi-doped goethite-hematite nanostructures and their catalytic activity in the degradation of an actual pesticide using a photo-Fenton-like process", *Appl. catal., B Environ.*, vol. 103, no. 3/4, pp. 351-361, 2011.
9. X. Gao, Hui Gu, Y. -X. Li, Z.-G. Yi, Miran Čeh, Kristina Žagar, "Structural evolution of the intergrowth bismuth-layered $Bi_7Ti_4NbO_{21}$", *J. Mater. Sci.*, vol. 46, no. 16, pp. 5423-5431, 2011.
10. Helder T. Gomes, Bruno Machado, Adrián M. T. Silva, Goran Dražić, Joaquim Luís Faria, "Photodeposition of Pt nanoparticles on TiO_2-carbon xerogel composites", *Mater. lett.*, vol. 65, no. 6, pp. 966-969, 2011.
11. Marijan Gotić, Goran Dražić, Svetozar Musić, "Hydrothermal synthesis of α-Fe_2O_3 nanorings with the help of divalent metal cations, Mn^{2+}, Cu^{2+}, Zn^{2+} and Ni^{2+}", In: Proceedings of the EUCMOS 2010, 30th European Congress on Molecular Spectroscopy, Florence, Italy, *J. Mol. Struct.,* vol. 993, no. 1/3, 2011.
12. Aljaž Iveković, Goran Dražić, Saša Novak, "Densification of a SiC-matrix by electrophoretic deposition and polymer infiltration and pyrolysis process", *J. Eur. Ceram. Soc.*, vol. 31, no. 5, pp. 833-840, 2011.
13. S. Kashimoto, Andraž Kocjan, Zvonko Jagličić, Simon Jazbec, H. Iga, T. Ishimasa, Janez Dolinšek, "Magnetic properties of σ- and hexagonal-

$Mn_{76}Si_{18}Cr_6$ approximant phases of a dodecagonal quasicrystal", *Phys. rev., B, Condens. matter mater. phys.*, vol. 84, no. 22, pp. 224201-1-224201-11, 2011.
14. Andraž Kocjan, Simon Kovačič, Anton Gradišek, Janez Kovač, Paul J. McGuiness, Tomaž Apih, Janez Dolinšek, Spomenka Kobe, "Selective hydrogenation of Ti-Zr-Ni alloys", *Int. j. hydrogen energy*, vol. 36, issue 4, pp. 3056-3061, 2011.
15. Andraž Kocjan, Paul J. McGuiness, Spomenka Kobe, "The impact of ambient gas on the magnetic properties of $Ti_{40}Zr_{40}Ni_{20}$ powders during mechanical alloying", *J. magn. magn. mater.*, vol. 323, issue 3-4, pp. 301-305, 2011.
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17. Zorica Lazarević, Č. Jovalekić, Aleksander Rečnik, V. N. Ivanovski, Miodrag Mitrić, Maja J. Romčević, N. Paunović, B. Đ. Cekić, Nebojša Romčević, "Study of manganese ferrite powders prepared by a soft mechanochemical route", *J. alloys compd.*, vol. 509, issue 41, pp. 9977-9985, 2011.
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19. D. Luković Golić, Goran Branković, Milica Počuča, Katarina Vojisavljević, Aleksander Rečnik, Nina Daneu, Slavko Bernik, M. Šćepanović, Dejan Poleti, Zorica Branković, "Structural characterization of self-assembled ZnO nanoparticles obtained by the sol-gel method from $Zn(CH_3COO)_2 \times 2H_2O$", *Nanotechnology (Bristol)*, vol. 22, no. 39, pp. 395603-1-395603-10, 2011.
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21. Paul J. McGuiness, Miha Čekada, Vincenc Nemanič, Bojan Zajec, Aleksander Rečnik, "Hydrogen permeation through TiAlN-coated Eurofer '97 steel", *Surf. coat. technol.*, vol. 205, no. 8/9, pp. 2709-2713, 2011.
22. Lei Meng, Liaoying Zheng, Lihong Cheng, Yao Zheng, Guorong Li, Slavko Bernik, "Enhancement of the electrical stability of ZnO varistors by a novel immersion process", *J. Am. Ceram. Soc.*, vol. 94, issue 9, pp. 2939-2945, 2011.
23. Jana Petković, Tadeja Küzma, Katja Rade, Saša Novak, Metka Filipič, "Pre-irradiation of anatase TiO2 particles with UV enhances their cytotoxic and genotoxic potential in human hepatoma HepG2 cells", *J. hazard. mater.*, vol. 196, pp. 145-152, 2011.
24. Peter Podbršček, Goran Dražić, Alojz Anžlovar, Zorica Crnjak Orel, "The preparation of zinc silicate/ZnO particles and their use as an efficient UV absorber", *Mater. res. bull.*, vol. 46, issue 11, pp. 2105-2111, 2011.
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26. Katja Rade, Saša Novak, Spomenka Kobe, "The shaping and densification of silicon carbide while avoiding alumina as a sintering additive", *J. mater. sci. eng., A*, vol. 1, no. 3A, pp. 301-311, 2011.
27. Nevenka Rajić, Đorđe Stojaković, Nina Daneu, Aleksander Rečnik, "The formation of oxide nanoparticles on the surface of natural clinoptilolite", *J. phys. chem. solids*, vol. 76, issue 6, pp. 800-803, 2011.
28. Aleksander Rečnik, "Mineralogische Expedition zum Mt. Malosa, Malawi", *Miner.-Welt*, vol. 22, no. 6, pp. 78-97, 2011.
29. Aleksander Rečnik, Janez Zavašnik, Tadej Dolenec, Bojan Režun, Uroš Herlec, "Az idrijai higanylelöhely (Szlovénia)", *Geoda*, vol. 21, no. 3, pp. 12-31, 2011.
30. Raquel P. Rocha, Adrián M. T. Silva, Goran Dražić, Manuel F. R. Pereira Pereira, José Luís Figueiredo, "Supported Pt-particles on multi-walled carbon nanotubes with controlled surface chemistry", *Mater. lett.*, vol. 66, no. 1, pp. 64-67, 2011.
31. Evangelia Sarantopoulou, Zoe Kollia, Goran Dražić, Spomenka Kobe, Nikolaos Spyropoulos Antonakakis, "Long-term oxidization and phase transition of InN nanotextures", In: Proceedings of the 11th Trends in NanoTechnology International Conference, TNT2010, Braga, Portugal, *Nanoscale Res. Lett.,* vol. 6, no. 1, pp. 387-1-387-8, 2011.
32. Nikolaos Spyropoulos Antonakakis, Evangelia Sarantopoulou, Zoe Kollia, Goran Dražić, Spomenka Kobe, "Schottky and charge memory effects in InN nanodomains", *Appl. phys. lett.*, vol. 99, no. 15, pp. 153110-1-153110-3, 2011.
33. Đorđe Stojaković, Jelena Milenković, Nina Daneu, Nevenka Rajić, "A study of the removal of copper ions from aqueous solution using Clinoptilolite from Serbia", *Clays and clay miner.*, vol. 59, no. 3, pp. 277-285, 2011.
34. Sašo Šturm, Andreja Benčan, Mehmet A. Gulgun, Barbara Malič, Marija Kosec, "Determining the stoichiometry of $(K,Na)NbO_3$ using optimized energy-dispersive X-ray spectroscopy and electron energy-loss spectroscopy analyses in a transmission electron microscope", *J. Am. Ceram. Soc.*, vol. 94, issue 8, pp. 2633-2639, 2011.
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36. Kristina Žagar, F. Hernandez-Ramirez, Joan Daniel Prades, Joan Ramón Morante, Aleksander Rečnik, Miran Čeh, "Characterization of individual barium titanate nanorods and their assessment as building blocks of new circuit architectures", *Nanotechnology (Bristol)*, vol. 22, no. 38, pp. 385501-1-385501-6, 2011.
37. Kristina Žagar, Aleksander Rečnik, Sašo Šturm, Andreja Gajović, Miran Čeh, "Structural and chemical characterization of $BaTiO_3$ nanorods", *Mater. res. bull.*, vol. 46, no. 3, pp. 366-371, 2011.
38. Kristina Žužek Rožman, Darja Pečko, Larisa Suhodolčan, Paul J. McGuiness, Spomenka Kobe, "Electrochemical syntheses of soft and hard magnetic $Fe_{50}Pd_{50}$-based nanotubes and their magnetic characterization", *J. alloys compd.*, vol. 509, issue 2, pp. 551-555, 2011.

Review Articles and Chapters in Books

1. Andreja Benčan, Elena Tchernychova, Sašo Šturm, Zoran Samardžija, Barbara Malič, Marija Kosec, "Approaches for a reliable compositional analysis of alkaline-based lead free perovskite ceramics using microanalytical methods", *Journal of advanced dielectrics*, vol. 1, no. 1, pp. 41-52, 2011.
2. Spomenka Kobe, Benjamin Podmiljšak, Paul J. McGuiness, Matej Komelj, "CMA's as magnetocaloric materials", In: *Complex metallic alloys: fundamentals and applications*, Jean-Marie Dubois, ed., Esther Belin-Ferré, ed., Weinheim, Wiley-VCH, 2011, pp. 317-363.
3. Paul J. McGuiness, Urša Pirnat, "Four steps to the hydrogen car", In: *Planet earth 2011 - global warming challenges and opportunities for policy and practice*, Elias G. Carayannis, ed., Rijeka, InTech, cop. 2011, pp. 425-446.
4. Saša Novak, Katja Koenig, Aljaž Iveković, "Electrophoretic deposition in production of ceramic matrix composites", In: *Electrophoretic deposition of nanomaterials*, (Nanostructure science and technology), James H. Dickerson, ed., Aldo R. Boccaccini, ed., New York [etc.], Springer, cop. 2011, pp. 295-348.
5. Matej Skočaj, Metka Filipič, Jana Petković, Saša Novak, "Titanium dioxide in our everyday life: is it safe?", *Radiol. oncol. (Ljubl.)*, vol. 45, no. 4, pp. 227-247, 2011.

Published Conference Papers

Invited Papers

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