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 considers both 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

The European project ROMEO (Replacement and Original Magnet Engineering Options) has come to an end and there were many activities before the finalization. The final task of the project was to design and make a prototype of an electric motor in collaboration with two co-operating partners: VALEO (France) and SIEMENS (Germany). A technology for improving the magnetic performance, developed in the Department for Nanostructured Materials, was chosen to be the most appropriate among those proposed by other academic and research-oriented partners. It is based on the grain-boundary diffusion process, which involves the electrophoretic deposition of TbF_3 as the initial step. The implementation of this technology gave the Nd-Fe-B permanent magnets a coercivity of more than 2000 kA/m and a remanence higher than 1.3 T at room temperature. These are the key magnetic properties that allow electric motors to operate at 150 °C. Besides ambitious magnetic properties, the use of essential heavy rare earths, which are identified as critical elements, is minimized down to only 1.37 wt. %, instead of 10–11 wt. % in the current state of the art. In our laboratory, more than 550 magnets were coated with TbF_3 powder prior to the annealing process. The electrophoretic deposition process enabled an even coating on each magnet, which is crucial for avoiding the use of excessive amounts of expensive coating. All of the magnets were then firmly packed into wooden boxes and double sealed in an argon atmosphere to avoid possible oxidation during transportation. The coated magnets were annealed in a vacuum furnace at the Vacuumschmelze company in Hanau (Germany). Those magnets with enhanced magnetic properties were then grinded to their final dimensions and embedded into the rotors of prototype electric motors.

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At the end of the year another EU FP7 project entitled "Nanocrystalline permanent magnets based on hybrid metal-ferrites" (**NANOPYME**) was finished. Within the frame of this project we prepared a hard-soft magnetic composite, which exhibited an increase in maximum energy product of 22 % when compared to the pure hard phase (used in a composite) magnet. For the preparation of the hard-soft magnetic composite we used hydrothermally synthesized Sr-ferrite as the hard magnetic phase and nanoparticles of Co-ferrite as the soft magnetic phase. The powders were compacted with spark-plasma sintering and the increase in the maximum energy product in the sintered composites is due to the exchange coupling between the hard and soft magnetic phases. The composites exhibit enhanced magnetic properties when compared to the single-phase materials used in the composites and had the best magnetic properties among all the materials prepared within the NANOPYME consortium.

In the frame of the European project **REProMag** we are developing and validating an innovative resource-efficient manufacturing route for rare-earth magnets that allows for the economically efficient production of net-shape magnetic parts with complex structures and geometries, while being 100% waste-free along the whole manufacturing chain. We use 100% recycled magnetic powder that is formed into complex shapes by mixing it with a polymer, which is removed after the process in order to achieve a dense sintered magnet. By optimizing the process of debinding and sintering, we have successfully removed the harmful excess of carbon, as a first stage of the project.

The international research project **MAG-DRIVE** is also focused on new permanent magnets for electric-vehicle drive applications. Besides K7 being the coordinator of the project, our scientific task is to perform structural characterization with scanning electron microscopy, magnetic characterization using a vibrating-sample magnetometer, and spark-plasma sintering of recycled powders.

In the frame of LIA - **International Laboratory between CNRS and JSI** - PACS$_2$, the following scientific results were obtained. The $Cu_5(Gd,Ca)$ metastable solid solution was prepared in different forms, including single-grain crystals. This series of compounds was selected from the studies performed within the CalGad-X PICS and was shown to produce an isomorphous, random substitution of Ca for Gd atoms in the hexagonal lattice, which is stabilized by the presence of calcium. The crystal structure of a single grain of composition close to $Cu_5(Gd_{0.5}Ca_{0.5})$ was refined. Transport properties were measured in the low- to room-temperature range. The surfaces were also characterized and we discovered unexpected catalytic properties of the Cu_5Gd allotrope.

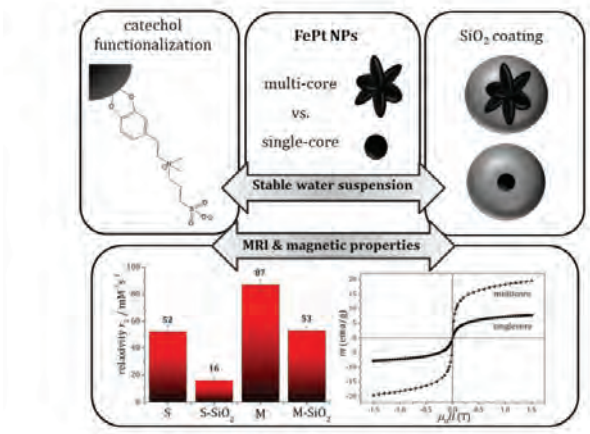

Figure 1: Formation of "multi-core" FePt nanoparticles results in an increased magnetization and consequently in higher MRI relaxivity values in comparison to their "single-core" counterparts. Functionalization with a bio-compatible zwitterionic dopamine ligand or coating with a SiO_2 shell enables the preparation of stable water suspensions, which are a prerequisite for further bio implementation.

A **new bulk glass-forming alloy** was identified from a study of substituting Gd or Ce atoms for Al atoms in the well-known Al-Cu-Fe icosahedral quasicrystal. The interval between the glass transition and crystallization was found to be large enough to allow the preparation of cm-size glassy samples by spark-plasma sintering. This finding is attractive enough to start a PhD thesis about the initiation of crystallization in such glasses and its influence on magnetic properties.

More exploratory research was dedicated to typical push-pull alloys. So far, no new compound with a giant unit cell was discovered, but these studies have enhanced our understanding of the miscibility gaps in the liquid state that characterize such systems.

FePd alloys are of particular interest due to the many possible applications that originate from their different chemical compositions. The electrodeposition process was first studied for single metals: Fe, Pd. In the end a comparison with a Fe–Pd alloy was performed. It was found that the deposition of Fe starts at 50 mV, the deposition of Pd at 200 mV and the deposition of the Fe–Pd alloy at 150 mV at more positive potentials, when instead of a Au electrode as the working electrode Fe, Pd or Fe–Pd monolayered deposits are already present. Furthermore, when Fe is accompanied with Pd, the deposition of Fe starts at more than 500 mV more positive potentials. Using the galvanostatic deposition, it was observed that in the case of the Fe–Pd-alloy deposition, Pd deposits first and due to its catalytic behaviour, it subsequently catalyses the reduction of Fe. These results are important since they reveal the "true" deposition behaviour of the Fe-Pd alloy, which is many times overlooked because the cyclic voltammetry is performed on substrates with different chemical compositions. The obtained electrodeposition conditions were further used to deposit 200-nm-thick and 3.5-μm-long fcc nanowires (NWs) with a consistent composition of $Fe_{48\pm3}Pd_{52\pm3}$ in an AAO template. Magnetic force microscopy (MFM) on a single Fe–Pd NW revealed its single-domain behaviour with the easy axis of magnetization along the long axis of the NW. The magnetization switching behaviour of a single Fe–Pd NW studied with MFM suggested a square-shaped magnetization curve (M/Ms = 1) with $Hc_{II} \approx 3.2$ kA/m. In addition, using in-field MFM techniques, the effects of dipolar interactions in a Fe–Pd array of NWs embedded in the AAO were determined. It was found that the dipolar interactions greatly reduce the parameters of the magnetic hysteresis loop, such as the coercivity, remanence, and switching-field distribution of the Fe–Pd NW array, which are important parameters for the consideration of these NW arrays as magnetic recording media.

In the frame of an ARRS project, **FePt nanoparticles** (NPs) were assessed for their possible bio applications. Since the magnetization value strongly influences the performance of the nanoparticles acting as the contrast-agent material for MRI, we have described processing routes for the synthesis of FePt nanoparticles of different sizes, which possess, consequently, different magnetization values. "Single-core" FePt nanoparticles of different sizes (3–15 nm) were prepared via one-step or two-step synthesis, with the latter exhibiting almost twice the magnetization ($m_{(1.5T)}$ = 14.5 emu/g) as compared to the nanoparticles formed via a one-step synthesis ($m_{(1.5T)}$ < 8 emu/g). Furthermore, we proposed the synthesis of "multi-core" FePt nanoparticles by changing the ratio between the two surfactants (oleylamine and oleic acid), exhibiting much higher magnetizations, i.e., 19.5 emu/g, without exceeding the superparamagnetic limit. Stable water suspensions of FePt NPs were prepared via functionalization with a biocompatible zwitterionic catechol ligand, for the first time, and via a SiO_2 coating. FePt nanoparticles showed promising MRI characteristics, with significant shortening of the transversal relaxation times, i.e., r_2 relaxivities that equal 52 $mM^{-1}s^{-1}$ for "single core" FePt and 87 $mM^{-1}s^{-1}$1 for "multi-core"

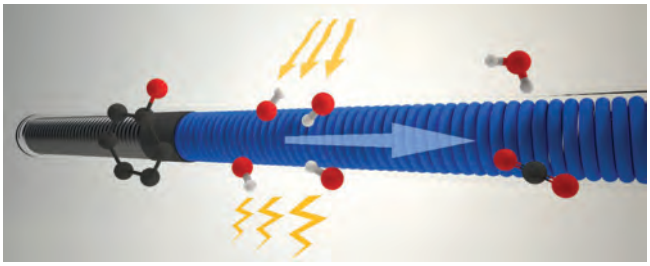

Figure 2: Schematic representation of phenol mineralization inside the continuous-flow photoelectrocatalytic microreactor. Degradation reaction takes place on the surface of the photocatalytically active coil in the presence of UV-light illumination, hydroxyl radicals, and external electrical potential.

FePt NPs, while exhibiting r_2/r_1 ratios above 10, which are ideal for MRI. The nonmagnetic SiO_2 coating "diluted" the magnetic effect of the FePt nanoparticles, resulting in lower MRI performance.

In the frame of the ARRS project "Bioresponsive magnetooptically coupled nanomaterial based systems for innovative skin cancer treatments", we explored the field of multimodal hybrid nanoparticles, which can be used for nanomedical applications by combining the focused localization and extraction of hybrid nanoparticles, using an external magnetic field and photothermally-responsive drug release and treatment. To realize this, we have combined photothermal and magnetic entities in an innovative material based on **FePt/SiO_2/Au hybrid nanoparticles**. The magnetic cores of FePt exhibit the superparamagnetic properties necessary for biomedical purposes, while the gold nano-shells absorb light in the near-infrared range, as predicted by our modelling. Our results showed that superparamagnetic components in the form of a FePt core can be successfully incorporated into silica/gold nano-shells. The multifunctional nature of such materials was successfully demonstrated by measuring their photothermal and magnetic response. We demonstrated that a high photothermal response can be achieved while irradiating a suspension of these hybrid nanoparticles with a low-energy NIR laser. In addition, using a separation/retention experiment under dynamic conditions we confirmed that these hybrid nanoparticles can be extracted using an external magnet. This opens up a "playground" of choices and a range of possibilities for in-vivo applications and confirms our idea that these nanoparticles can be successfully applied in real biological systems.

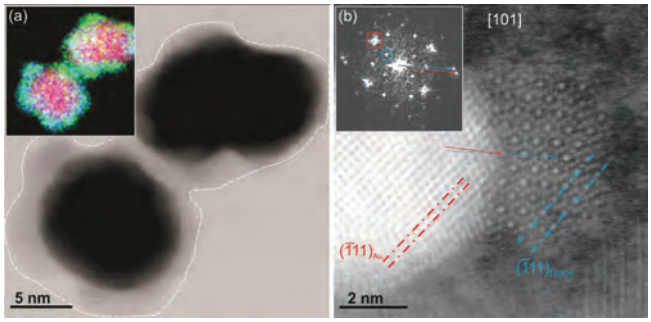

Figure 3: (a) High-resolution BF-STEM image of Au and Fe-oxide NPs. The dashed contour lines distinguish the Fe-oxide particles from the support carbon film. The inset shows the corresponding composed elemental map (Au: red, Fe: green and O: blue). (b) Atomic resolution HAADF-STEM image of the interface between the Au and Fe_3O_4 particles observed in the [101] zone axis. The red and blue dashed parallel lines represent the (1̄11) lattice planes for the Au and Fe_3O_4 crystal structures, respectively.

For the first time, we report on a one-step synthesis and surface functionalization of dumbbell-like **Au/Fe_3O_4 nanoparticles**, which is a key step for their use as hybrid organic-inorganic nanotheranostic systems. The exact morphology of these dumbbell-like gold-iron oxide nanoparticles at the atomic scale was determined by high-resolution HAADF-STEM imaging. We were able to confirm that the dumbbell-like gold-iron oxide nanoparticles were composed of a gold particle with the fcc structure observed in the $[101]_{Au}$ zone axis and cubic Fe_3O_4 with the inverse spinel structure, which was also observed in the $[101]_{Fe3O4}$ crystallographic projection. The interface between the Au and Fe_3O_4 crystal phases was manifested by the {111} faceted gold surface. The analysis of the crystallographic relationship between both structures indicates the epitaxial growth of Fe_3O_4 $(111)_{Fe3O4}$ planes onto the $(111)_{Au}$ Au surface. The observed slight misalignment of the gold and Fe_3O_4 crystal lattices was explained by the small lattice mismatch (~3%) between the theoretical values of Au $2d_{111}$-(0.471 nm) and Fe_3O_4 d_{111}(0.485 nm), which could provoke local structural compensation at the interface, enabling the epitaxial growth of Fe_3O_4 onto the surface of the Au. In the theoretical part of our research, we applied the density-functional theory to investigate the influence of the exchange-correlation effects on the electron-phonon coupling, and consequently on the predicted phase-transition temperature in the superconducting H_3S under high pressure ~ 2GPa. We also worked on the theoretical reconstruction of the twin boundary on some minerals. We developed a method for the calculation of the electron-phonon coupling in the frame of the density-functional and Hartree-Fock theories. It was found that the correct description of the hydrogen phonon states required the presence of the exact correlation term.

In the frame of European programme **EUROFusion** we continued the development of structural materials based on tungsten for the highly thermally loaded structural parts of demonstration fusion reactors. Since the first results revealed critical drawbacks of the reinforcement with SiC or TiC particles, which readily react with a tungsten matrix, we focused our research on the addition of W_2C as a reinforcement. We confirmed that the W_2C particles can be synthesised from added graphene or an organic precursor directly in the tungsten matrix during sintering and that, as proposed, the particles concentrate at the grain boundaries. Moreover, in collaboration with the UK industrial partner TISICS Ltd, the first metal-matrix composite samples with long SiC fibres have been prepared.

Encouraging testing results for a hydrothermally synthesized TiO_2 anatase coating, obtained within the **BioTiNet** (FP7-ITN) project, led us towards a further comprehensive analysis of the effect of the coating on the physico-chemical properties and the biological response. In collaboration with the Biotechnical Faculty and the Faculty for Mechanical Engineering, University of Ljubljana, we confirmed that the topographic characteristics have a more pronounced effect on bacterial attachment than the surface charge and wetting. By tailoring the coating surface, an attachment of bacteria of less than 5% has been achieved. The importance of the obtained results has been reflected in a signed licence agreement for the exploitation of undisclosed knowledge with a foreign partner.

In the final year of **COST Action NAMABIO** ("From nano to macro biomaterials and application to stem cells regenerative orthopaedic and dental medicine"), our main focus was on the characterization of 3D bioactive composite scaffolds for stem cells. In collaboration with Vienna University of Technology and Aalto University we compared several methods for mechanical characterization and concluded that shear rheology and compression

tests are the most appropriate. In collaboration with Belgrade University we have tested the bioactivity of samples with and without bioactive glass particles in a perfusion bioreactor, and proved that the addition of such particles drastically enhances the scaffold's properties. Composite samples with a silk fibroin or gellan gum matrix, which showed the most promising results, have been sterilized in the Triga reactor (in cooperation with the department F8) and tested at the company Animacell d.o.o. Together with Educel d.o.o., bioactive glass/protein scaffolds for the treatment of osteochondral defects were developed and characterized. The positive influence of bioactive glass on the protein structure, solubility and bioactivity were determined in collaboration with the Veterinary Faculty and the Faculty for Chemistry and Chemical Technology. We joined the **COST Action NEWGEN** (New Generation Biomimetic and Customized Implants for Bone Engineering) that will help us to continue our research in the field of tissue engineering.

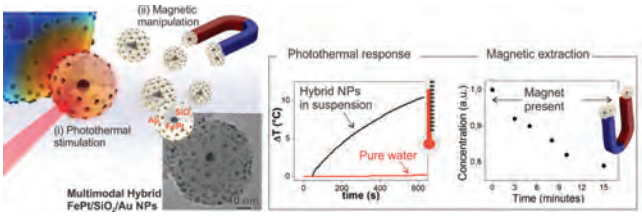

Figure 4: Multimodal hybrid NP functionalities for nanomedical applications by combining photothermal stimulation and manipulation with an external magnetic field.

Great attention has been paid to submicron TiO_2 particles added to food and food-contact materials. Within the project **ISOFood**, various techniques have been tested for the extraction of TiO_2 particles. As a model system, we selected chewing gums available on the Slovenian market. The extracted particles have been proved to be anatase, with a particle size below 200 nm. Similarly, nanoparticles were found in white, non-stick "ceramic" pans. The presence of anatase particles with a size of 100-200 nm and silica particles with a size below 50 nm were confirmed in the used pans.

Since submicron or even nanometric TiO_2 particles are increasingly present in food, many investigations are dealing with questions about the risks to health. However, as various techniques and powders are used in the studies, there is still no agreement about this. In order to shed more light on the importance of the mentioned variations, we performed a comprehensive study of five titania powders in aqueous suspensions. We confirmed that TiO_2 powders significantly differ among each other, not only in terms of particle size and crystal form, but also in surface charge, which affects dispersibility and hence, presumably, also bioavailability. Further investigations will be oriented towards an examination of the effect of TiO_2 nanoparticles on cells.

In the field of **photocatalysis** our research was focused on the degradation of water pollutants inside an in-house-developed photoelectrocatalytic microreactor. We have studied the influence of different operational parameters of the photoelectrocatalytic microreactor on the contaminants' mineralization rate. The most significant change in the pollutants' degradation rate was achieved by applying an external anodic potential to the anode of titania nanotubes. The applied potential significantly reduced the photogenerated electron-hole recombination rate and enabled the complete mineralization of phenol to water and carbon dioxide while consuming very low amounts of electrical energy.

In the field of **thermoelectrics** we studied the influence of niobium doping on the $Sr_3Ti_2O_7$ monocrystal formation and growth. Doped monocrystals were used as seeds in strontium titanate in order to improve its thermoelectric properties. By adding different amounts of niobium we concluded that most of the niobium incorporates on titanium sites in the $Sr_3Ti_2O_7$ crystal lattice. The remaining niobium forms various strontium titanium niobates. Based on our results we proposed a mechanism of titanium incorporation in $Sr_3(Ti,Nb)_2O_7$. We also studied the influence of SrO and CaO additions to $Sr(Ti_{0.8}Nb_{0.2})O_3$ on its thermoelectric properties. It was found that the addition of SrO and/or CaO resulted in the formation of a three-dimensional network of Ruddlesden-Popper-like planar faults along the {001} crystal planes, which lowered the thermal conductivity of the material. Consequently, the material exhibited an increased figure of merit ZT. In cooperation with the German Aerospace Center in Cologne, we tested a new method for the synthesis of thermoelectric strontium titanate: DSP (Direct current sinter press). The Seebeck coefficient, electrical conductivity and thermal conductivity were determined for all the synthesized samples.

In the field of oxide thermoelectric (TE) materials, we also studied the preparation of n-type $(ZnO)_kIn_2O_3$ ceramics using microwave sintering. In a much shorter time of about 1 hour, microwave sintering enabled the preparation of $(ZnO)_kIn_2O_3$ ceramics with TE characteristics similar to the case of classical sintering.

The influence of the synthesis conditions of the $Ca_3Co_4O_9$ p-type thermoelectric phase and different methods for the further processing of Ca349 ceramics (classical sintering, hot pressing, SPS, cold pressing) on the microstructure, morphology of the grains, density and texturing, and consequently their TE characteristics, were studied. The possibilities and limitations of the microstructure tailoring for an improvement in the TE characteristics of the Ca349 ceramics were determined. Ca349 ceramics with the highest ZT of 0.31 at 600 °C reported so far in the literature were successfully produced. Samples of thermoelectic microgenerators were successfully prepared by screen printing on alumina substrates from p-type $Ca_3Co_4O_9$ and n-type $(ZnO)_5In_2O_3$ thermoelectric materials. We were among the first to explore the possibilities and challenges of screen-printing technology in the preparation of TE oxide microgenerators.

Perovskite materials such as $BaTiO_3$ and Fe-$SrTiO_3$ nanostructures are suitable for many applications, such as humidity or oxygen sensing and tuneable HTS (high-temperature superconducting) microwave filters. The potential advantages of the nanostructured forms have been, however, scarcely explored compared to other oxides. The synthesis of perovskite nanostructures via sol-gel electrophoretic deposition (EPD) into anodic aluminium oxide (AAO) membranes has proven to be a very successful and useful method for processing one-dimensional metal oxides that are used for humidity and oxygen sensors.

The influence of WO_3 on the type of Bi_2O_3-rich phase at the grain boundaries and hence the electrical characteristics of ZnO-Bi_2O_3-based varistor ceramics was studied. It showed that the optimal addition of 0.4 mol.% of WO_3 significantly improves the current-voltage (I-U) characteristics of varistor ceramics sintered at 950 °C. The results are important for the preparation of varistor ceramics at a significantly lower sintering temperature than the typically used 1200 °C.

We developed a new type of ZnO-based varistor ceramic with a coefficient of nonlinearity as high as 40 without the addition of Bi_2O_3 as a standard dopant for I-U nonlinearity, which also results in the formation of a liquid phase at the sintering temperature and is highly volatile. Hence, the use of ZnO varistor ceramics doped with small amounts of oxides of Ca, Co and Cr can have an important advantage for the preparation of varistors in comparison to the use of classical varistor ceramics containing Bi_2O_3.

The development of ink with a high solids load of varistor powder of 70%, having the proper rheological properties for screen printing, enabled us to prepare thick-film varistors on alumina substrates with a dense and homogeneous microstructure, and excellent current-voltage (I-U) characteristics with a high coefficient of nonlinearity of 24, after firing for only 15 minutes at a low temperature of 900 °C. From zinc nitrate and sodium hydroxide solutions in a mixture of water and ethylene glycol we prepared, under hydrothermal conditions at 90 °C, ZnO nano-crystals that were functionalized by the chemical binding of ionic liquids. In this way we have prepared materials with a very good antimicrobial activity.

We have successfully completed a project for the VARSI company entitled “Current challenges in the development and manufacture of varistors”.

The second part of the investigation of the mechanism for the topotaxial transformation of ilmenite to rutile and hematite was finished during the past year. The first part of the investigation was studies of naturally oriented rutile/hematite intergrowths, while in the second part we tried to reproduce the transformation of an ilmenite single crystal to rutile and hematite during oxidation in air. Different conditions led to different crystallographic orientation relationships between the rutile and hematite in natural samples and ilmenite samples heated in air. The mechanism of transformation includes the initial oxidation of the Fe^{2+} in ilmenite to Fe^{3+} and its diffusion to the surface that triggers the exsolution of Ti ions within the parent ilmenite structure to form rutile lamellae. The kinetics of the diffusion controls the orientation relationships. However, when the diffusion is slow, the cations have enough time to adopt the energetically most favourable positions and to form a tetragonally deformed rutile structure. In the spinel-chrysoberyl system, we have synthesized ceramic samples of taaffeite, where we detected only one stable phase ($BeMg_3Al_8O_{16}$). Surface analysis of the pellet has indicated, besides taaffeite crystals, also complex spinel twin crystals, in the epitaxial growth of taaffeite crystals on a spinel octahedron. For all these situations, structural models were prepared. Mathematical simulations of high-resolution images and density-functional theory (DFT) to define a rigid model are in progress.

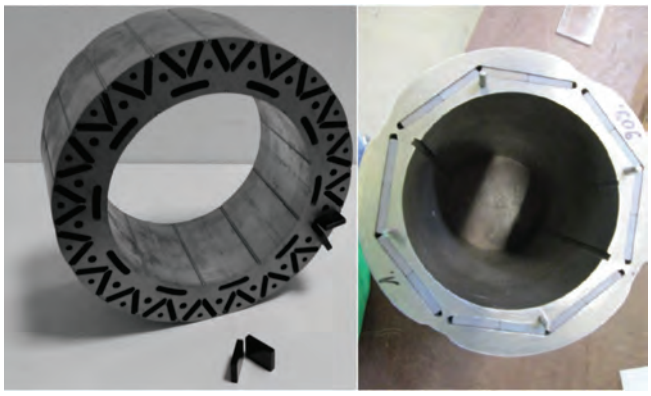

Figure 5: Magnets developed in the department for the ROMEO project inbuilt in the motor of the electric car in the company Valeo. The electric motor test showed 13 % better performance compared to the reference motor, while the torque was increased by 11 % at the ΔT of 95 K. Both parameters contribute to a higher efficiency.

We continued with the synthesis procedures for the enhanced growth of multiply twinned rutile-type TiO_2. For the production of highly branched rutile, we need the following hydrothermal conditions: high temperature, low precursor concentration or low reagent concentration. The final crystals are growing with the attachment of approximately 5-nm-thick rutile fibres (following the oriented attachment mechanism), aggregated more frequently along the {110} (growth) and, less frequently, along the {101} planes, causing the formation of {101} twins. With a TEM analysis we confirmed that branching is achieved by a second generation of twinning. A new area of research, which we opened in 2015, is the study of twinning in cassiterite (SnO_2) in the field of varistor ceramics. Based on microstructural studies of ZnO ceramics, where the grain growth was successfully controlled by the formation of inversion boundaries, we made an attempt to apply the same principle to SnO_2 ceramics. We developed homogenous SnO_2-based varistor ceramics doped with CoO and Nb_2O_5, where we measured a high non-linear coefficient (49.1), matching those of ZnO-based varistors. The highest non-linear coefficient was measured for SnO_2 ceramics, where

the observed density of the twin boundaries appears to be highest. With a TEM investigation we will further explain the role of twin boundaries in SnO_2 grains and their influence on the resulting electrical properties.

We have implemented advanced analytical methods for the characterization of innovative materials on the micrometre and sub-micrometre scales: high-resolution scanning electron microscopy (FEGSEM), qualitative and quantitative elemental electron-probe microanalysis (EPMA) with energy-dispersive and wavelength-dispersive X-ray spectroscopies (EDS, WDS) and electron backscatter diffraction (EBSD). The use of optimized methods made it possible to achieve reliable, precise and accurate analytical results, which are necessary to obtain the ultimate microstructural, microchemical and microcrystallographic characterizations of materials. We have investigated various materials: ceramic and metallic thin films, complex metallic alloys, magnetocalorics, magnetic materials, ferroelectric perovskites, nanorods and nanoparticles, and quasicrystalline alloys.

With the implementation of the EBSD method, we were able to get additional and very important information about the microcrystallographic properties of materials, i.e., the crystallinity, the crystallographic orientation of particular phases and the texture. In this way, using precise EBSD analyses, we have investigated complex Al-Mn-Cu alloys and have successfully directly verified the presence of two quasicrystalline phases in the material, i.e., icosahedral quasicrystals with a 5-fold symmetry and decagonal quasicrystals with a 10-fold symmetry.

We have collaborated with partners from industry and other research institutions by performing analyses on specific materials. The main collaborations were realized with SwatyComet Maribor, Energetika Ljubljana, UL-NTF Department of Materials and Metallurgy, Ljubljana, UL Faculty of Electrical Engineering, Ljubljana.

One of the important research areas of the group is the implementation of various **electron microscopy** analytical techniques within the existing EU project ESTEEM2, such as electron-energy-loss spectroscopy (EELS), high-resolution scanning transmission electron microscopy (STEM, HAADF-STEM), electron holography and mechanical preparation of the TEM samples. The implementation of various electron microscopy analytical techniques and the possibility for the researchers to access the research infrastructure for electron microscopy within the Center for Electron Microscopy and Microanalysis (CEMM) is of utmost importance for the research group.

Some outstanding publications in the past three years

1. Komelj, Matej, Krakauer, Henry. Electron-phonon coupling and exchange-correlation effects in superconducting H3S under high pressure. *Physical review. B, Condensed matter and materials physics*, ISSN 1098-0121, 2015, vol. 92, issue 20, str. 205125-1-205125-5, doi: 10.1103/PhysRevB.92.205125.
2. Kostevšek, Nina, Šturm, Sašo, Žužek Rožman, Kristina, et al. The one-step synthesis and surface functionalization of dumbbell-like gold-iron oxide nanoparticles : a chitosan-based nanotheranostic system. *Chemical communications*, ISSN 1359-7345, [in press] 2015, 4 str., doi: 10.1039/C5CC08275G.
3. Kovič, Andrej, Mrzel, Aleš, Ravnik, Jan, Šturm, Sašo, Vilfan, Mojca. Surface decoration of MoSI nanowires and MoS_2 multi-wall nanotubes and platinum nanoparticle encapsulation. *Materials letters*, ISSN 0167-577X, 2015, vol. 159, str. 333-336, doi: 10.1016/j.mat.let. 2015.07.021.
4. Lorenzetti, Martina, Dogša, Iztok, Stošicki, Tjaša, Stopar, David, Kalin, Mitjan, Kobe, Spomenka, Novak, Saša. The influence of surface modification on bacterial adhesion to titanium-based substrates. *ACS applied materials & interfaces*, ISSN 1944-8244. [Print ed.], 2015, vol. 7, str. 1644-1651, ilustr., doi: 10.1021/am507148n.
5. Rečnik, Aleksander, Stanković, Nadežda, Daneu, Nina. Topotaxial reactions during the genesis of oriented rutile/hematite intergrowths from Mwinilunga (Zambia). *Contributions to Mineralogy and Petrology*, ISSN 0010-7999, 2015, vol. 169, str. 1-22, doi: 10.1007/s00410-015-1107-x.

Organization of conferences, congresses and meetings

1. Opening of "The international associated laboratory Push-Pull AlloyS And Complex CompoundS ($PACS_2$): from bulk properties to surface functions" (LIA $PACS_2$), Ljubljana, 6–9 January 2015
2. Project Meeting, ESTEEM2: Enabling Science and Technology through European Electron Microscopy, Ljubljana, 23–24 February 2015
3. EMAS 2015 - 14th European Workshop on Modern Developments and Applications in Microbeam Analysis, Portorož, 3–7 May 2015
4. Eurofusion: WPMAT-HHFM Project Monitoring Meeting, Ljubljana, 2–3 June 2015
5. Y1 Annual meeting of LIA $PACS_2$: "The international associated laboratory Push-Pull AlloyS And Complex CompoundS ($PACS_2$): from bulk properties to surface functions", Ljubljana, 17–18 December 2015
6. Final project meeting, ROMEO: Replacement and Original Magnet Engineering Options, Ljubljana, 26–27 November 2015
7. 1st Slovenian Meeting of Microscopists, Piran, 18–19 May 2015 (co-organisation)

8. 23rd International Conference on Materials and Technologies, 27–30 September, Portorož (co-organisation)
9. MCM2015, Multinational Congress on Microscopy, Eger, Hungary, 23–28 August 2015 (members of the International Advisory Board)
10. C-MAC Euroschool, Bratislava, Slovakia, 31 May – 5 June 2015 (members of Science Board and General Assembly in European Integrated Center for the Development of New Metallic Alloys and Compounds (C-MAC))

Awards and appointments

1. Martina Lorenzetti, European Doctoral Award 2015, European Society for Biomaterials, 2 September 2015
2. Vanja Jordan, "Hydrothermal synthesis of highly branched rutile-type TiO_2" (co-authors, Goran Dražić, Aleksander Rečnik). Best Young Lecturer Award, 12th Multinational Congress on Microscopy 2015, Eger, Hungary, 23-28 August 2015
3. Rok Kocen, "Viscoelastic properties of hydrogel - 'ceramic' composites for tissue-engineering scaffolds" (co-authors: Ana Gantar, Saša Novak, Christian Hellmich, Michael Gasik). Award for the Best Scientific Work, Bulgarian Society of Biorheology, 4 September 2015, presented at the 5th Euro Summer School on Biorheology, Varna, Bulgaria, 1–5 September 2015
4. Rok Kocen, "Measuring viscoelasticity of hydrogel-BAG composites" (co-authors, Ana Gantar, Saša Novak, Christian Hellmich, Michael Gasik). Best Oral Presentation Award, 23rd International Conference on Materials and Technology, Portorož, 28–30 September 2015

INTERNATIONAL PROJECTS

1. Selective Laser Melting (SLM) and Spark Plasma Sintering (SPS) of Cost Effective Rare-earth based Permanent Magnets for Electrical Machines
   Prof. Spomenka Kobe
   ABB Switzerland Ltd
2. 7FP - ESTEEM 2; Enabling Science and Technology through European Electron Microscopy
   Prof. Miran Čeh
   European Commission
3. 7FP - NANOPYME; Nanocrystalline Permanent Magnets Based on Hybrid Metal-Ferrites
   Asst. Prof. Kristina Žužek Rožman
   European Commission
4. 7FP - ROMEO, Replacement and Original Magnet Engineering Options
   Prof. Spomenka Kobe
   European Commission
5. 7FP - MAG-DRIVE; New Permanent Magnets for Electric-Vehicle Drive Application
   Asst. Prof. Matej Andrej Komelj
   European Commission
6. 7 FP; ERA CHAIR ISO-FOOD - Era Chairs for Isotope Techniques in Food Quality, Safety and Traceability
   Prof. Saša Novak Krmpotič
   European Commission
7. MODEF - Creazione e sperimentazione congiunta di modelli per l"ottimizzazione dell"utilizzo di energia fotovoltaica
   Dr. Zoran Samardžija
   Unindustria Rovigo
8. COST ES1205; The Transfer of Engineered Nanomaterials from Wastewater Treatment & Stormwater to Rivers
   Prof. Saša Novak Krmpotič
   Cost Office
9. COST MP1005, NAMABIO; From Nano to Macro Biomaterials (Design, Processing, Characterization, Modelling) and Applications to Stem Cells Regenerative Orthopedic and Dental Medicine
   Prof. Saša Novak Krmpotič
   Cost Office
10. COST MP1301 NEWGEN; New Generation Biomimetic and Customized Implants for Bone Engineering
    Prof. Saša Novak Krmpotič
    Cost Office
11. H2020 - REProMag; Resource Efficient Production Route for Rare Earth Magnets
    Dr. Benjamin Podmiljšak
    European Commission
12. H2020 - DEMETER; Training Network for the Design and Recycling of Rare-Earth Permanent Magnet Motors and Generators in Hybrid and Full Electric Vehicles
    Asst. Prof. Kristina Žužek Rožman
    European Commission
13. Materials-PPPT-FU: WC and SiC Reinforced Tungsten
    Prof. Saša Novak Krmpotič
    EURATOM
14. Eurofusion Education-ED-FU
    Prof. Saša Novak Krmpotič
    EURATOM
15. Characterisation of Growth Features and Planar Defects in Crystals Grown Under Hydrothermal Conditions
    Asst. Prof. Nina Daneu
    Slovenian Research Agency
16. Biomimetic Characterisation of Bioactive Composit Scaffolds for Bone and Osteochondral Tissue Repair
    Prof. Saša Novak Krmpotič
    Slovenian Research Agency
17. Development of Oxide Thermoelectric Materials for Waste-heat Recovery into Electricity
    Prof. Slavko Bernik
    Slovenian Research Agency
18. Electron Microscopy Study of the Degradation Kinetics of Porous Bioactive Glass based Novel Drug Eluting Implants (Coating/3D Scaffolds) as a Function of Hard Tissue Regeneration for Treatment of Osteoporotic Fractures in Elderly Patients
    Asst. Prof. Nina Daneu
    Slovenian Research Agency
19. Nucleation and Photocatalytic Activity of Nanoparticles Studied in Actual Liquid Environment under Transmission Electron Microscope
    Prof. Sašo Šturm
    Slovenian Research Agency
20. Atomic-scale Studies of Topotaxial Reactions in Minerals with the Rutile and Corundum-type Structures
    Asst. Prof. Nina Daneu
    Slovenian Research Agency
21. Structural and Microstructural Engineering of ZnO Thermoelectrics (SMEZ)
    Prof. Slavko Bernik
    Slovenian Research Agency
22. The Study of Strain in Nonstoichiometric Perovskites by Applying X-Ray Powder Diffraction Methods, Dilatometry and Advanced Techniques of Electron Microscopy
    Prof. Sašo Šturm
    Slovenian Research Agency
23. Advanced Methods and Technologies for Processing of a New Generation of ZnO-based Varistor Ceramics
    Prof. Slavko Bernik
    Chinese Academy Of Sciences
24. Irradiation and Analysis of Nano SiC Samples
    Dr. Aljaž Iveković
    National Nuclear Research Center

RESEARCH PROGRAMS

1. Nanostructured Materials
   Prof. Spomenka Kobe
2. Engineering and Bio-ceramics
   Asst. Prof. Andraž Kocjan

R & D GRANTS AND CONTRACTS

1. Structure and Chemical Composition Study of Surfaces and Interfaces with Highresolution Scanning Transmission Electron Microscopy at Atomic Level
   Prof. Aleksander Rečnik
2. Atomic-scale studies of initial stages of phase transformations in minerals
   Asst. Prof. Nina Daneu
3. Bio-responsive magneto-optically coupled nanomaterial-based systems for innovative skin cancer treatments
   Prof. Sašo Šturm
4. Tridimensional bioactive glass and biopolymer composite scaffolds for treatment of osteochondral defects developed due to the articular cartilage lesions
   Dr. Nataša Drnovšek
   Ministry of Education, Science and Sport of the Republic of Slovenia

NEW CONTRACTS

1. The study of self-cleaning and abrasion resisting properties of carbon-, para-aramid- or glass-fibre-based composite materials by applying photocatalytic and/or mechanical resistant nanoparticles
   Prof. Sašo Šturm
   Cdt Group d. o. o.
2. Multipole magnetisation of NdFeB bonded magnets for rotor application
   Prof. Spomenka Kobe
   Kolektor Kfh d. o. o.
3. Current challenges in developing and producing varistors
   Prof. Slavko Bernik
   RCeNem Novi materiali

VISITORS FROM ABROAD

1. Tian Tian, Chinese Academy of Science – SICCAS, Shanghai, China, 23 July – 18 November 2015
2. Prof. Jean-Marie Dubois, Institut Jean Lamour, Nancy, France, 6–16 January 2015
3. Prof. Jean-Francois Tassin, Dr. Pascal Breuilles, Dr. Francesca Grassia, Centre national de la recherche scientifique, Paris, France, 7–9 January 2015
4. Dr. Julian Ledieu, Dr. Vincent Fournée, Dr. Pascal Boulet, Institut Jean Lamour, Nancy, France, 7–9 January 2015
5. Dr. Goran Branković, Marina Vuković and Sanja Pršić, Institute for Multidisciplinary Research, Belgrade, Serbia, 19–26 January 2015
6. Dr. Milivoj Plodinec, Institut Rudjer Bošković, Zagreb, Croatia, 23–27 February 2015
7. Prof. Jean-Marie Dubois, Institut Jean Lamour, Nancy, France, 14–19 February, 22–26 March, 26 April – 2 May 2015, 1–4 June 2015
8. Dr. Emmanuel Guilmeau and Dr. Etienne Savary, Universite de Caen, Laboratoire de Cristallographie er Sciences des Materiaux, CRISMAT, Caen, France, 22–24 April 2015
9. Dr. Andreja Gajović and Dr. Milivoj Plodinec, Institut Rudjer Bošković, Zagreb, Croatia, 25–27 May 2015
10. Dr. Michael Rieth, Dr. Eberhard Diegele, Dr. Steffen Antusch, Dr. Ermile Gaganidze, Dr. Wolfgang Krauss, Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany, Dr. Freimut Koch, Alexander von Müller, Dipl. Ing., Dr. Johann Riesch, Dr. Hans Maier, Max-Planck-Institut für Plasmaphysik, Garching, Germany, Dr. Carmen García-Rosales, CEIT Centro de Estudios e Investigaciones Técnicas de Gipuzkoa, Gipuzkoa, Spain, Dr. Gerald Pintsuk, Dr. Andrey Litnovsky, Dr. Marius Wirtz, Dr. Jan Willem Coenen, Forschungszentrum Jülich, Jülich, Germany, Dr. Andrei Galatanu, National Institute of Materials Physics, Ilfov, Romania, M.Sc. Vladica Nikolić, Eirch-Schmid – Institut für Materialwissenschaft der Österreichischen Akademie der Wissenschaften, Leoben, Austria, Dr. Marianne Richou, CEA-DSM-IRFM, Service Intégration Plasma-Paroi, SIPP, Cadarache, France, Dr. Marta Dias, Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, Lisbona, Portugal, Prof. Sergei Dudarev, Culham Centre for Fusion Energy, Abingdon, United Kingdom, Prof. María Sánchez Martínez, DCIM - Grupo de Ciencia e Ingeniería de Materiales, Universidad Rey Juan Carlos, Madrid, Spain, Dr. Roberto Coppola, ENEA-Casaccia, FISNUC, Rome, Italy
11. Prof. Guorong Li, Prof. Haosu Luo, Dr. Liaoying Zheng, Shanghai Institute of Ceramics, Chinese Academy of Science - SICCAS, Shanghai, China, and Prof. Jinrong Cheng, University Shanghai, China, 24–31 July 2015
12. Dr. Masahiro Kawasaki, JEOL USA, Inc., Peabody, Massachusetts, USA, 29 June – 9 July 2015
13. Prof. Yilmaz Ozmen, Pamukkale University, Technology Faculty, Biomedical Engineering Dept., Denizli, Turkey, 2 June 2015
14. Dr. Andrea Čobić, Faculty of Science, University of Zagreb, Zagreb, Croatia, 15 June – 30 September 2015
15. Prof. George S. Dulikravich, MAIDROC Laboratory, Department of Mechanical and Materials Engineering, Florida International University, Miami, Florida, USA, 19 June 2015
16. Dr. Goran Branković, Dr. Zorica Branković, Institute for Multidisciplinary Research, Belgrade, Serbia; Prof. Jose Michel Haddad, UNIARA - Centro Universitario de Araraquara, Araraquare, Brazil, 5–9 August 2015
17. Dr. Goran Branković, Marina Vuković in Sanja Pršić, Institute for Multidisciplinary Research, Belgrade, Serbia, 11–18 August 2015
18. Benjamin Pages and Emmanuelle De Clermont Gallerande, Ecole des Mines de Nancy, Nancy, France, 1–31 August 2015
19. Dr. Milivoj Plodinec, Lara Štajner and Iva Buljan, Institut Rudjer Bošković, Zagreb, Croatia, 4–6 August 2015
20. Dr. Yuki Kimura, Dr. Jun Kawano and Dr. Tomoa Yamazaki, Hokkaido University, Sapporo, Shinnosuke Ishizuka, Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan, 29 September – 4 October 2015
21. Dr. Ivna Kavre Piltaver, Department of Physics, University of Rijeka, Croatia, 7 September – 23 October 2015
22. Dr. Pavel Gavryushkin and Dr. Victor Gabrielevich Thomas, Sobolev Institute of Geology and Mineralogy SB, RAS, Novosibirsk, Russia, 31 October – 14 November 2015
23. Dr. Chuck Henager, Nuclear Science Division, Pacific Northwest National Laboratory, Richland, WA, USA, 18–20 October 2015
24. Kaya Aysen, Institute of Natural and Applied Sciences, Hatay, Turkey, 1 October 2015 – 30 June 2016
25. Sayatan Ray, Central Glass & Ceramic Research Institute, Kolkata, India, 8–28 December 2015
26. Dr. Bojana Obradović and Jovana Zvicer, Tehniško metalurški fakultet, University of Belgrade, Belgrade, Serbia, 11–18 November 2015
27. Dr. Nora Dempsey, Anja Backen, Institut Néel, Grenoble, France, Prof. Gutfleisch Oliver and Christoph Schwöbel, Dipl. Eng., Technische Universität Darmstadt, Darmstadt, Germany, Prof. Josef Fidler, M.Sc. Peter Toson, M.Sc. Gregor Zickler, Ahmad Asali, Technische Universität Wien, Vienna, Austria, Ing. Florian Bittner, Torsten Mix, Leibniz-Institut für Festkörper- und Werkstofforschung, Dresden, Germany, Dr. Jean Marc Dubus, VALEO equipements electriques moteur, Creteil, France, Prof. Thomas Schrefl, M.Sc. Alexander Kovacs, Fachhochschule St. Pölten - FHSTP, St. Pölten, Austria, M.Sc. Pelin Tozman, Dr. Munuswamy Venkatesan, Trinity College Dublin, Ireland, Ing. Hristian Naumoski, Daimler, Stuttgart, Germany, Annemarie Gemperli and Dr. Jürgen Höck, TEMAS AG, Arbon, Switzerland, Dr. Matthias Katter, Ing. Kaan Üstüner, Vacuumschmelze GmbH & Co. KG, Hanau, Germany, Dr. Du Van Ann and Dr. Michael Krispin, Siemens AG, Erlangen, Germany, Dr. Boris Saje, Kolektor, Idrija, 26–27 November 2015
28. Prof. Michael Coey, Trinity College, Dublin, Ireland, 25 November – 2 December 2015
29. Prof. Cleva Ow Yang, Sabancı University, Nanotechnology Research and Application Center, Istanbul, Turkey, 9–13 December 2015
30. Prof. Ludwig Schulz, Leibniz-Institut für Festkörper- und Werkstofforschung, Dresden, Germany, 16–18 December 2015
31. Prof. Jean-Marie Dubois, Dr. Julien Zollinger, Dr. Pascal Boulet, Dr. Marie-Cécile de Weerd, Dr. Julian Ledieu and Dr. Alain Hazotte, Institut Jean Lamour, Nancy, France, Prof. Boštjan Markoli and Dr. Iztok Naglič, Faculty for Natural Sciences, University of Ljubljana, Dr. Blaž Likozar, National Institute of Chemistry, Ljubljana, 17–18 December 2015
32. Dr. Andreja Gajovič, Institut Rudjer Bošković, Zagreb, Croatia, 14–18 December 2015

STAFF

Researchers

1. Prof. Slavko Bernik
2. Prof. Miran Čeh
3. Asst. Prof. Nina Daneu
4. Prof. Jean Marie Dubois
5. **Prof. Spomenka Kobe, Head**
6. Asst. Prof. Matej Andrej Komelj
7. *Asst. Prof. Paul John McGuiness, left 01.03.15*
8. Prof. Saša Novak Krmpotič
9. Dr. Benjamin Podmiljšak
10. Prof. Aleksander Rečnik
11. Dr. Zoran Samardžija
12. Prof. Sašo Šturm
13. Dr. Kristina Žagar Soderžnik
14. Asst. Prof. Kristina Žužek Rožman

Postdoctoral associates

15. Dr. Nataša Drnovšek
16. Dr. Aljaž Iveković
17. Dr. Petra Jenuš
18. Dr. Martina Lorenzetti
19. Dr. Darja Pečko
20. Dr. Matejka Podlogar
21. Dr. Marko Soderžnik

Postgraduates

22. Anže Abram, B. Sc.
23. Bojan Ambrožič, B. Sc.

24. Muhammad Shahid Arshad, B. Sc.
25. Sandra Drev, B. Sc.
26. Ana Gantar, B. Sc.
27. Marja Jerič, B. Sc.
28. Vanja Jordan, B. Sc.
29. Luka Kelhar, B. Sc.
30. Rok Kocen, B. Sc.
31. Nina Kostevšek, B. Sc.
32. Mateja Košir, B. Sc.
33. Mojca Presečnik, B. Sc.
34. *Rok Rudež, B. Sc., left 01.09.15*
35. *Nadežda Stanković, B. Sc., left 01.11.15*
36. Luka Suhadolnik, B. Sc.
37. Sara Tominc, B. Sc.
38. Tomaž Tomše, B. Sc.
39. Špela Trafela, B. Sc.

Technical officers

40. Dr. Jana Ferčič
41. *Medeja Gec, B. Sc., retired 31.12.15*
42. *Špela Klemenčič, B. Sc., left 09.01.15*
43. Martin Topole, B. Sc.
44. Sanja Fidler, B. Sc.

BIBLIOGRAPHY

Original Article

1. Marjeta Čepin, Vasko Jovanovski, Matejka Podlogar, Zorica Crnjak Orel, "Amino- and ionic liquid-functionalised nanocrystalline ZnO via silane anchoring - an antimicrobial synergy", *J. mater. chem. B*, vol. 3, iss. 6, pp. 1059-1067, Feb. 2015.
2. Matej Dolenec, Todor Serafimovski, Nina Daneu, Tadej Dolenec, Nastja Rogan Šmuc, Petra Vrhovnik, Sonja Lojen, "The case of the carbonatite-like dyke of the Madenska River complex at the Kriva Lakavica section in the Republic of Macedonia: oxygen and carbon isotopic constraints", *Turk. j. eart. sci.*, vol. 24, no. 6, pp. 627-639, 2015.
3. Sandra Drev, Matej Komelj, Matjaž Mazaj, Nina Daneu, Aleksander Rečnik, "Structural investigation of (130) twins and rutile precipitates in chrysoberyl crystals from Rio das Pratinhas in Bahia (Brazil)", *Am. mineral.*, vol. 100, no. 4, pp. 861-871, 2015.
4. Nataša Drnovšek, Urška Dragin Jerman, Rok Romih, Miran Čeh, Matevž Gorenšek, Jozef Vleugels, Saša Novak, "Improvement of osseointegration of Ti and Ti-alloys by hydrothermally prepared bioactive anatase coating", *Int. j. nano biomater.*, vol. 6, no. 1, pp. 18-28, 2015.
5. Matjaž Godec, Tatjana Večko Pirtovšek, Barbara Šetina, Paul J. McGuiness, Jaka Burja, Bojan Podgornik, "Surface and bulk carbide transformations in high-speed steel", *Scientific reports*, vol. 5, pp. 1-11, Nov. 2015.
6. Aljaž Iveković, Andrei Galatanu, Saša Novak, "Low-activation W-Si-C composites for fusion application", *Fusion eng. des.*, vol. 100, pp. 638-645, 2015.
7. Aljaž Iveković, Saša Novak, "Electrophoretic (infiltration) deposition of thick conductive fiber preforms", *J. Electrochem. Soc.*, vol. 162, no. 11, pp. D3049-D3056, 2015.
8. Aljaž Iveković, Saša Novak, Marko Lukek, Mitjan Kalin, "Aqueous electrophoretic deposition of bulk polyether ether ketone (PEEK)", *J. mater. process. technol.*, vol. 223, pp. 58-64, 2015.
9. Matej Komelj, "Influence of strain on the properties of CeRuPO and CeOsPO Kondo systems: letter to the editor", *J. magn. magn. mater.*, vol. 393, pp. 175-178, 2015.
10. Matej Komelj, Henry Krakauer, "Electron-phonon coupling and exchange-correlation effects in superconducting H_3S under high pressure", *Phys. rev., B, Condens. matter mater. phys.*, vol. 92, issue 20, pp. 205125-1-205125-5, 2015.
11. Nina Kostevšek, Sašo Šturm, Igor Serša, Ana Sepe, Maarten Bloemen, Thierry Verbiest, Spomenka Kobe, Kristina Žužek Rožman, ""Single- and "multi-core" FePt nanoparticles: from controlled synthesis via zwitterionic and silica biofunctionalization to MRI applications", *J. nanopart. res.*, vol. 17, no. 12, pp. 464-1-464-15, 2015.
12. Nina Kostevšek, Kristina Žužek Rožman, Muhammad Shahid Arshad, Matjaž Spreitzer, Spomenka Kobe, Sašo Šturm, "Multimodal hybrid FePt/SiO_2/Au nanoparticles for nanomedical applications ecombining photothermal stimulation and manipulation with an external magnetic field", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 119, issue 28, pp. 16374-16382, 2015.
13. Andrej Kovič, Aleš Mrzel, Jan Ravnik, Sašo Šturm, Mojca Vilfan, "Surface decoration of MoSI nanowires and MoS_2 multi-wall nanotubes and platinum nanoparticle encapsulation", *Mater. lett.*, vol. 159, pp. 333-336, 2015.
14. Matic Krivec, Gerald Mc Gunnigle, Anže Abram, Dieter Maier, Roland Waldner, Johanna M. Gostner, Florian Űberall, Raimund Leitner, "Quantitative ethylene measurements with MO_x chemiresistive sensors at different relative air humidities", *Sensors*, vol. 15, no. 11, pp. 28088-28098, 2015.
15. Mukta Vishwanath Kulkarni, Yogita Patil-Sen, Ita Junkar, Chandrashekhar Kulkarni, Martina Lorenzetti, Aleš Iglič, "Wettability studies of topologically distinct titanium surfaces", *Colloids surf., B Biointerfaces*, vol. 129, pp. 47-53, May 2015.
16. Z. Ž. Lazarević, Čedomir Jovalekić, A. Milutinović, Nina Daneu, Maja J. Romčević, Đorđe Jovanović, Nebojša Romčević, "Spectroscopy investigation of nanostructured nickel-zinc ferrite obtained by mechanochemical synthesis", *Optoelectron. Adv. Mater. Rapid Commun.*, vol. 9, no. 1/2, pp. 102-106, 2015.
17. Zorica Lazarević, Aleksandra Milutinović Živin, Čedomir Jovalekić, Valentin Ivanovski, Nina Daneu, Ivan Mađarević, Nebojša Romčević, "Spectroscopy investigation of nanostructured nickel-zinc ferrite obtained by mechanochemical synthesis", *Mater. res. bull.*, vol. 63, pp. 239-247, 2015.
18. Martina Lorenzetti, Giulia Bernardini, Thomas Luxbacher, Annalisa Santucci, Spomenka Kobe, Saša Novak, "Surface properties of nanocrystalline TiO_2 coatings in relation to the in vitro plasma protein adsorption", *Biomedical materials*, vol. 10, pp. 045012-1-045012-11, 2015.
19. Martina Lorenzetti, Olga Dakischew, Katja Trinkaus, Katrin Susanne Lips, Reinhard Schnettler, Spomenka Kobe, Saša Novak, "Enhanced osteogenesis on titanium implants by UVB photofunctionalization of hydrothermally grown TiO_2 coatings", *J. biomater. appl.*, vol. 30, no. 1, pp. 71-84, 2015.
20. Martina Lorenzetti, Iztok Dogša, Tjaša Stošicki, David Stopar, Mitjan Kalin, Spomenka Kobe, Saša Novak, "The influence of surface modification on bacterial adhesion to titanium-based substrates", *ACS appl. mater. interfaces*, vol. 7, pp. 1644-1651, 2015.
21. Paul J. McGuiness *et al.* (24 authors), "Replacement and Original Magnet Engineering Options (ROMEOs): a European seventh framework project to develop advanced permanent magnets without, or with reduced use of, critical raw materials", *JOM (1989)*, vol. 67, issue 6, pp. 1306-1317, 2015.
22. Darja Pečko, Nina Kostevšek, Boris Pihlar, Zoran Samardžija, Spomenka Kobe, Kristina Žužek Rožman, "Electrochemical studies of Fe and Pd deposition and their influence on the co-deposition of the Fe-Pd alloy", *Journal of electroanalytical chemistry*, vol. 738, pp. 51-60, 2015.
23. Darja Pečko, Sašo Šturm, Spomenka Kobe, Kristina Žužek Rožman, "Potentiostatically electrodeposited hard-magnetic Fe-Pd-based nanowires", *IEEE trans. magn.*, vol. 51, no. 7, pp. 9600204 -1-9600204-4, 2015.
24. Elio Alberto Périgo, Denis Mettus, Elliot Gilbert, P. Hautle, Nemanja Niketic, Paul J. McGuiness, "Magnetic microstructure of a textured Nd-Fe-B sintered magnet characterized by small-angle neutron scattering", *J. alloys compd.*, vol. 661, pp. 110-114, 2015.
25. Benjamin Podmiljšak, Paul J. McGuiness, Spomenka Kobe, "Complex metallic alloys for applications in magnetic refrigeration", *Recent patents on materials science*, vol. 8, no. 2, pp. 129-154, 2015.
26. Aleksander Rečnik, Nadežda Stanković, Nina Daneu, "Topotaxial reactions during the genesis of oriented rutile/hematite intergrowths

from Mwinilunga (Zambia)", *Contrib. Mineral. Petrol.*, vol. 169, pp. 1-22, 2015.
27. Rok Rudež, Piotr Markowski, Mojca Presečnik, Mateja Košir, Andrzej Dziedzic, Slavko Bernik, "Development of thick-film thermoelectric microgenerators based on *p*-type $Ca_3Co_4O_9$ and *n*-type $(ZnO)_5In_2O_3$ legs", *Ceram. int.*, vol. 41, iss. 10, part A, pp. 13201-13209, 2015.
28. Rok Rudež, Jernej Pavlič, Slavko Bernik, "Preparation and influence of highly concentrated screen-printing inks on the development and characteristics of thick-film varistors", *J. Eur. Ceram. Soc.*, vol. 35, no. 11, pp. 3013-2023, 2015.
29. Zoran Samardžija, "Quantitative microanalysis of $(1-x)Pb(Mg_{1/3}Nb_{2/3})O_3xxPbTiO_3$ (PMNT) ferroelectric ceramics", *Microsc. microanal.*, vol. 21, iss. 5, pp. 1138-1144, 2015.
30. Michail Samouhos, Janez Zavašnik, Aleksander Rečnik, Anthanasios Godelitsas, Elias Chatzitheodoridis, Yiannis Sanakis, "Spectroscopic and nanoscale characterization of blue-coloured smithsonite ($ZnCO_3$) from Lavrion historical mines (Greece)", *Period. mineral. (Testo stamp.)*, vol. 84, no. 2, pp. 373-388, 2015.
31. Anchalee Samphao, Kanjana Kunpatee, Sanchai Prayoonpokarach, Jatuporn Wittayakun, L'ubomír Švorc, Dalibor M. Stanković, Kristina Žagar, Miran Čeh, Kurt Kalcher, "An ethanol biosensor based on simple immobilization of alcohol dehydrogenase on Fe_3O_4@Au nanoparticle", *Electroanalysis*, vol. 27, no. 12, pp. 2829-2837, 2015.
32. Marian Stingaciu, Martin Topole, Paul J. McGuiness, Mogens Christensen, "Magnetic properties of ball-milled $SrFe_{12}O_{19}$ particles consolidated by Spark-Plasma Sintering", *Scientific reports*, 5, pp. 1-8, 2015.
33. Xiangkai Xiao, Liaoying Zheng, Lihong Cheng, Tian Tian, Xuezheng Ruan, Matejka Podlogar, Slavko Bernik, Guorong Li, "Influence of WO_3-doping on the microstructure and electrical properties of ZnO – $Bi2O_3$ varistor ceramics sintered at 950°C", *J. Am. Ceram. Soc.*, vol. 98, issue 4, pp. 1356-1363, 2015.
34. Maša Zalaznik, Saša Novak, Miroslav Huskić, Mitjan Kalin, "Tribological behaviour of a PEEK polymer containing solid MoS2 lubricants", *Lubr. sci.*, pp. [1-16], 2015.
35. Andrej Zorko, Jure Kokalj, Matej Komelj, Othon Adamopoulos, H. Luetkens, Denis Arčon, Alexandros Lappas, "Magnetic inhomogeneity on a triangular lattice: the magnetic-exchange versus the elastic energy and the role of disorder", *Scientific reports*, vol. 5, pp. 9272-1- 9272-8, 2015.

Published Conference Contribution (invited lecture)

1. Zoran Samardžija, "Electron probe microanalysis of dopant concentrations in complex perovskite ferroelectrics", In: *Book of tutorials and abstracts*, EMAS 2015, 14th European Workshop on Modern Developments and Applications in Microbeam Analysis, Portorož, Slovenia, 3 to 7 May 2015, Antwerpen, EMAS, 2015, pp. 201-213.
2. Sašo Šturm, Elena Tchernychova, Cleva Ow-Yang, Guliz Inan, Marja Jerič, Miran Čeh, "Applications of scanning transmission electron microscopy (STEM)", In: *Book of tutorials and abstracts*, EMAS 2015, 14th European Workshop on Modern Developments and Applications in Microbeam Analysis, Portorož, Slovenia, 3 to 7 May 2015, Antwerpen, EMAS, 2015, pp. 177-186.
3. Sašo Šturm, Kristina Žužek Rožman, Boštjan Markoli, Evangelia Sarantopoulou, Zoe Kollia, Alciviadis-Constantinos Cefalas, Spomenka Kobe, "Physical-metallurgical aspect of formation of core-shell and hollow nanospheres", In: *Proceedings and Book of Abstracts*, Marija Korać, ed., Belgrade, Association of Metallurgical Engineers of Serbia (AMES), 2015, pp. 37- 47.

Published Conference Contribution

1. Muhammad Shahid Arshad, Darja Pečko, Janez Zavašnik, Sašo Šturm, Spomenka Kobe, Kristina Žužek Rožman, et al., "Cobalt-platinum alloy nanostructures as potential candidates for racetrack magnetic data storage devices", In: *Zbornik: 2. del: part 2*, 7. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 7th Jožef Stefan International Postgraduate School Students' Conference, 20.-22. 5. 2015, Ljubljana, Andraž Rešetič, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2015, zv. 1, pp. 270-277.
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Patent Application

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Mentoring

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