

DEPARTMENT FOR NANOSTRUCTURED MATERIALS K-7

The basic and applied research in the Department for Nanostructured Materials includes ceramic materials, 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.

In the frame of the European Network of Excellence called CMA (Complex Metallic Alloys) we studied materials with the potential for **hydrogen storage** in the systems $\text{Ti}_{40}\text{Zr}_{40}\text{Ni}_{20}$, $\text{Ti}_{45}\text{Zr}_{35}\text{Ni}_{17}\text{Cu}_3$, $\text{Ti}_{40}\text{Hf}_{40}\text{Ni}_{20}$, $\text{Ti}_{45}\text{Hf}_{35}\text{Ni}_{17}\text{Cu}_3$. Elemental powders were mixed in the proper ratios and mechanically alloyed in a planetary ball-mill in an argon atmosphere. After different alloying times (0, 20, 40, 60, 80 and 100 hours) we analysed the samples using x-ray diffraction, vibrating-sample magnetometry and differential scanning calorimetry. The last of these provided us with crystallization temperatures, enthalpies and activation energies of the various samples. We also did the amorphisation of the $\text{Ti}_{40}\text{Zr}_{40}\text{Ni}_{20}$ material in a hydrogen atmosphere, but this material remained partially crystalline and very reactive to the air because the surfaces of the nanoparticles were very clean. We published an article in the Journal of Alloys and Compounds and presented our results at the 14th Conference on Materials and Technologies in Portorož, Slovenia. We completed the installation of our external laboratory and a device for high-pressure hydrogen absorption. Hydrided Ni-Ti-Zr/Hf samples (amorphous and crystalline) were sent to Korea for deuterization; these samples were subsequently analysed by ²HMR at the F5 department.

We continued our research on **thin films of intermetallic alloys** of rare earths and transition metals prepared by pulsed-laser deposition and characterized using SQUID magnetometry, scanning electron microscopy (SEM), x-ray photoelectron spectroscopy (XPS) and atomic-force/magnetic-force microscopy.

We started research in the field of magnetocaloric materials for use in magnetic coolers. This work is focused on the $\text{Gd}_5(\text{Si}_x\text{Ge}_{1-x})_4$ system. Samples with different compositions were produced using two methods, arc-melting and mechanical alloying, both with subsequent homogenization. The samples were then characterized with powder x-ray diffraction (XRD), SEM and transmission electron microscopy (TEM). The final goal is to process a **material with a large magnetocaloric effect** that will be cheaper than the existing Ga, the material which is currently used for this application.

We investigated technologically interesting materials using calculations within the framework of the density-functional theory. Research was focused on the **magnetism of monatomic nanowires** and on the influence of nonmagnetic substrates on their properties, as well as on the simulation of the nuclear-magnetic resonance (NMR) spectra of complex metallic alloys.

In the field of **ZnO ceramics**, grain-growth studies indicated that inversion boundaries (IBs) are growth faults that control the growth of ZnO grains. Low-temperature experiments have shown that in the ZnO-SnO₂ system IBs form before the Zn₂SnO₄ spinel phase and grains with IBs grow exaggeratedly at the expense of the normal ZnO grains until they completely dominate the microstructure. Depending on the oxidation state of the IB-forming dopant we have identified two competing mechanisms of IB nucleation: (i) internal diffusion, and (ii) surface nucleation and growth. The first mechanism is typical for III⁺ dopants and is controlled by Zn-vacancy diffusion, whereas the second mechanism holds for all IB-forming dopants and is controlled by the chemisorption of the dopants on Zn-deficient (0001) surfaces. In both cases the driving force for the inversion is the preservation of the local charge balance.

We continued our research within the European fusion programme EURATOM/Fusion. The development of a **SiC/SiC composite for the first-wall blanket of a future fusion reactor** was largely focused on densification studies of SiC-based matrix material. By using the complementary techniques of high-resolution TEM and XPS we



Head:
Prof. Spomenka Kobe

We analysed the atomic-scale structure and chemistry of (111) twins in MgAl_2O_4 spinel crystals from the Pinpyit locality near Mogok (Myanmar) using the complementary methods of high-resolution transmission electron microscopy (HRTEM).

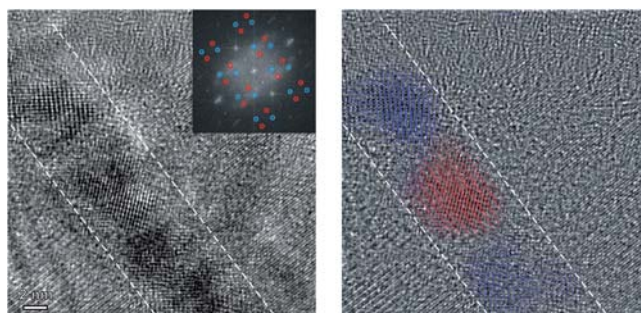


Figure 1: Nanotwins of ilmenite between (301) twinned rutile

studied (in collaboration with the F4 department) the surface composition of SiC powders and its effect on densification. We developed techniques for modifying SiC powder with a thin coating of aluminium or magnesium hydroxide. The results show that a 2–3-nm-thick AlOOH layer makes the powder behave in an alumina-like way. The colloidal behaviour of suspensions and the properties of SiC fibres were also investigated with the aim to effectively infiltrate SiC-fibre woven using vacuum slip infiltration or electrophoretic deposition (EPD). We studied

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the wettability of the hydrophobic SiC fibres with two different silicones, polymer and surface-active agents and different coatings on the SiC fibres (carbon, CrN). The microhardnesses of both the components of the SiC/SiC composite prepared using infiltration were measured, and the propagation of the obtained cracks was observed.

The basic research on **EPD** was focused on the deposition of alumina powder from ethanol-based suspensions, where we used submicrometer and nanometre powder. We studied the colloidal properties of alumina-ethanol suspensions and on the basis of the obtained results we prepared suitable suspensions for EPD. The microstructures of the EPD compacts were characterized by SEM. Since the nanometre alumina powder is highly agglomerated, which has a negative effect on the final density of the sintered compacts, we tried to find a suitable de-agglomeration technique.

The research on the tribological behaviour of ceramic materials was continued in collaboration with the Faculty for Mechanical Engineering, University of Ljubljana. Functionally graded composites of Al_2O_3 -ZTA- Al_2O_3 , developed in the frame of the EU's 5FP Biograd were investigated, and it has been shown that due to residual compressive stresses in the alumina surface layer, the wear resistance of the composite is higher than that for monolithic alumina. Furthermore, **a new concept for the boundary lubrication of ceramics** based on water using surface-charge adjustment was published.

In the frame of a new EU 6FP Integrated Project we began a collaboration with an international team with the aim to develop **a new generation of bone implants** with improved integration. Within the project, a coating that

should improve the implant's integration with bone tissue and prevent early inflammation will be developed. By engineering the substrate and coating the macro- and microstructure, natural bone will be imitated. Accordingly, the research is supported by a study of the self-organization of natural skeletons. We also began research in the field of bone-tissue engineering. Commonly used bone implants that are usually made of titanium alloys often lead to stress shielding of the bone and can cause bacterial infections, which requires another operation. For this reason the aim of our work was to modify the implant's surface to obtain a structural similarity between the bone and the implant and thus enable osseointegration (the integration of the bone and the host tissue). At the same time, with the deposition of biocompatible and bioactive coatings, like bioglasses and calcium phosphate, we want to improve the bioactivity that will stimulate osseointegration and prevent the formation of a biofilm on the implant surface that can cause inflammation after surgery.

The synthesis of **perovskite nanowires** based on template-assisted processing via sol-gel EPD was studied. As a starting material for the fabrication of perovskite nanowires SrTiO_3 -, BaTiO_3 - and CaTiO_3 -based ceramics were implemented. In this study we are promoting a new synthesis procedure, which enables the structuring of the perovskite in the form of nanowires with a high aspect ratio. The development of the fabrication of such perovskite nanowires promises various interesting industrial applications in the field of nanotechnology.

As a result of extensive research on the whereabouts of minerals in Slovenia we have prepared **a book entitled 'Mineral localities of Slovenia'**. In this book we have documented the most important mineralogical treasures of Slovenia. Compared to other similar works in this field we have specifically focused on the relations between individual mineral occurrences and their geological setting and tectonics. The book describes the basic principles of rock formation, their recrystallization during tectonic processes and the setting up of the conditions for crystal nucleation and growth. The book has 384 pages and describes 43 of the most important surface mineral localities in Slovenia.

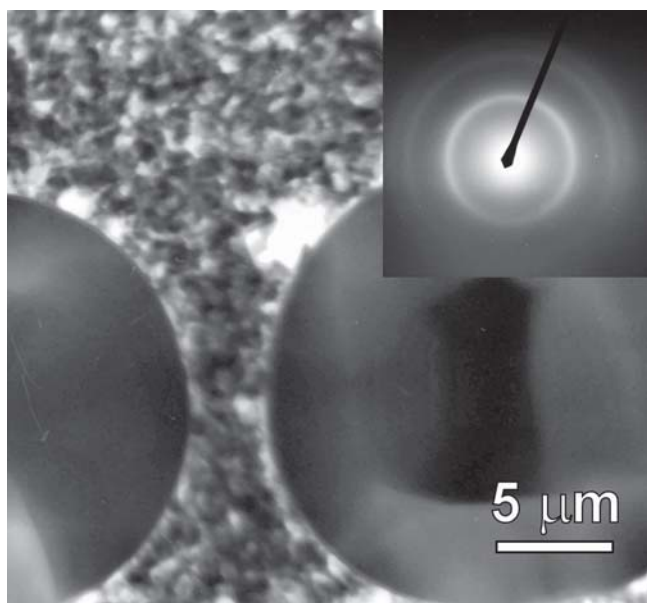


Figure 2: TEM (transmission electron microscopy) micrograph of the cross-section of amorphous SiC fibres embedded in fine-grained SiC matrix.

In the field of analytical electron microscopy our studies were focused on the development and **implementation of high-resolution high-angle annular dark-field scanning-transmission electron microscopy (HAADF-STEM) (Z-contrast)**, which enables a quantitative determination of the chemical composition on an atomic scale by using HAADF-STEM imaging. The algorithm is based on a quantitative correlation between simulated and experimental HAADF-STEM images. The final result of the HAADF-STEM analysis is a corresponding atomic model with an optimized chemical composition of the individual atomic columns. In the case of $\text{Ba}_2\text{NaNb}_3\text{O}_{10}$, with a complex tungsten bronze-type structure, we showed that the local lattice distortions significantly influence the experimentally determined intensities of the atomic columns. A quantitative interpretation of the intensities, i.e., the determination of the chemical composition, is only possible if the exact crystal structure and the value of the Debye-Waller factor are known. Only then can the intensities of the atomic columns in simulated images correspond to the true values and be successfully compared with the intensities in simulated images. HAADF-STEM was also used to determine the thickness and deformation of the crystal lattice of individual GaN and GaAlN layers in a GaN/GaAlN superstructure, which was composed of 200 consecutive GaN and GaAlN layers.

We analyzed the atomic-scale structure and chemistry of **(111) twins in MgAl_2O_4 spinel crystals** from the Pinyit locality near Mogok, Myanmar, using complementary method of high-resolution transmission electron microscopy (HRTEM). The (111) twins in spinel can be crystallographically described by a 180° rotation of the oxygen sublattice normal to the twin composition plane. This operation generates a local hcp stacking in an otherwise ccp lattice and maintains the regular sequence of kagome and mixed layers. This stacking is triggered by the presence of beryllium, which replaces magnesium cations in the twin-boundary tetrahedral sites. The Be-rich twin-boundary structure is closely related to the BeAl_2O_4 (chrysoberyl) and taaffeite group of intermediate polytypic minerals. Based on this we conclude that the formation of (111) twins in spinel is a preparatory stage of polytype formation (taaffeite) and is a result of the thermodynamically favourable formation of hcp stacking due to Be incorporation in the {111} planes of the spinel structure in the nucleation stage of crystal growth. In addition to spinel twins we also clarified the mechanism for the formation of (301) rutile twins from Diamantina (Brazil). HRTEM analyses revealed that these twins contain ilmenite lamella (up to a few nanometres thick) between the rutile domains in the orientation relationship $(301)_R|[100]_R|(100)_I|[001]_I|(301)_R|[010]_R$. The ilmenite lamella is additionally twinned, which suggests its mechanism of formation from primary hydroxides. The contact (301) rutile twins grow from hydrothermal solutions in which grains with a tivanite-type structure (rutile-goethite intergrowths) form at the beginning. These grains are already twinned because of the mechanism of their formation. On monoclinic tivanite platelets, which are additionally twinned, rutile is able to crystallise in two twinned orientations on both sides of the grain. The tivanite lamella is transformed to ilmenite in a subsequent process of recrystallisation.

As part of an international collaboration with Korea, piezoelectric bulk PMN-PT single crystals were studied. The microstructure, orientation and composition of PMN-PT single crystals grown from a BaTiO_3 single-crystal seed were studied in detail using advanced electron-probe micro-analysis wavelength-dispersive spectroscopy (EPMA-WDXS) and the electron-backscatter diffraction (EBSD) technique.

Some members of the department are, with part of the research and development program, heavily involved in managing 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 a research infrastructure for electron microscopy is of utmost importance for numerous research institutions, industrial partners as well as for graduate and post-graduate education. The analyses and expertise in the field of transmission electron microscopy, electron-probe microanalysis (SEM, energy-dispersive x-ray spectroscopy, WDXS) can be used to help industry and other research institutions, ETA-Cerkno, Comet, LEK, Belinka, EMO-Kemija, Gorenje-NO, Kemijski Inštitut, Donit-Tesnit, BIA-Separations, Faculty of Natural Sciences, University of Ljubljana, as well as other departments from the Jožef Stefan Institute (F3, K3, F4, F7 and F5).

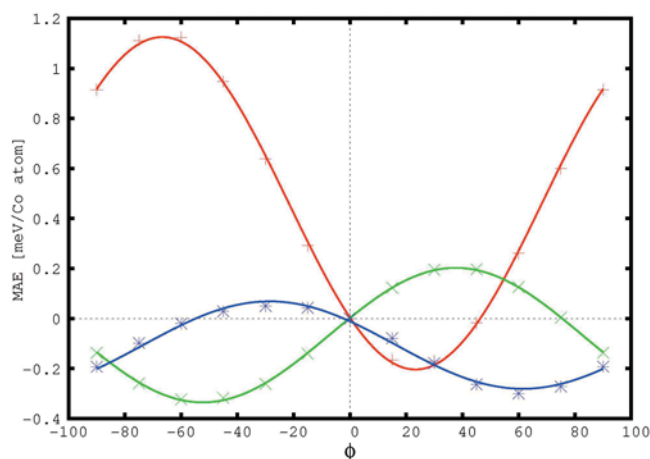


Figure 3: The calculated magnetic-anisotropy energy for a Pt-supported Co nanowire as a function of the magnetization direction in the plane perpendicular to the wire by taking into account the spin-orbit coupling for all atoms (red), and just the Co (green) or Pt atoms (blue).

Dr. Nina Daneu, a member of the Department for Nanostructured Materials, was one of the three recipients of the Jožef Stefan Golden Emblem Prize for the most outstanding contributions to science in PhD dissertations in the field of natural sciences in Slovenia.

Awards and appointments

1. Dr. Nina Daneu: Jožef Stefan Golden Emblem Prize for the most outstanding contributions to science in PhD dissertations in the field of natural sciences in Slovenia, Ljubljana, Jožef Stefan Institute, 24 March 2006
2. Andraž Kocjan: "Ti-Zr(Hf)-Ni Quasicrystals for Hydrogen Storage". Winning contribution in the young scientists' lecture competition at the 14th Conference on Materials and Technologies, Portorož, 16–18 October 2006

Organization of conferences, congresses and meetings

1. 14th Conference on Materials and Technology, Portorož, 16–18 October 2006 (co-organisation)
2. European School in Materials Science, Ljubljana, 22–27 May 2006 (co-organisation)
3. Nineteenth International Workshop on Rare Earth Permanent Magnets and Their Application (REPM'06), Beijing, China, 26 August – 1 September 2006 (members of the International Scientific Advisory Committee)
4. 16th International Microscopy Congress (IMC16), Sapporo, Japan, 3–8 September 2006 (members of the International Scientific Advisory Committee)

Some outstanding publications in 2006

1. M. Komelj, Influence of the substrate on the magnetic anisotropy of monatomic nanowires, *Phys. Rev. B* 73 (2006), 134428.
2. M. Kalin, S. Novak, J. Vižintin, Surface charge as a new concept for boundary lubrication of ceramics with water, *J. phys., D, Appl. Phys.*, 39 (2006), 3138-3149.
3. M. Shiojiri, M. Čeh, S. Šturm, C. Chuo, J. T. Hsu, J. R. Yang, H. Saijo, Structural and compositional analyses of a strained AlGaN/GaN superlattice. *J. Appl. Phys.*, 100 (2006), 03110-1-03110-7.

BIBLIOGRAPHY

ORIGINAL ARTICLES

1. Ž. Bihar, Ante Bilušić, J. Lukatela, A. Smontara, Peter Jeglič, Paul J. McGuinness, Janez Dolinšek, Zvonko Jagličič, Jozef Janovec, V. Demange, J. M. Dubois
Magnetic, electrical and thermal transport properties of Al-Cr-Fe approximant phases
In: J. alloys compd., Vol. 407, pp. 65-73, 2006.
2. Janez Dolinšek, Paul J. McGuinness, Martin Klanjšek, I. Smiljanić, Ana Smontara, E. S. Zijlstra, S. K. Bose, I. R. Fisher, M. J. Kramer, P. C. Canfield
Extrinsic origin of the insulating behavior of polygrain icosahedral Al-Pd-Re quasicrystals
In: Phys. rev., B, Condens. matter mater. phys., Vol. 74, pp. 134201-1-134201-7, 2006.
3. G. Gassner, Vesna Šrot, (10 authors)
Structure of sputtered nanocomposite CrC/a-C: H thin films
In: J. vac. sci. technol., B, Microelectron. nanometer struct. process. meas. phenom., Vol. 24, No. 4, pp. 1837-1843, 2006.
4. Mitjan Kalin, Goran Dražič, Saša Novak, Jože Vižintin
Wear mechanisms associated with the lubrication of zirconia ceramics in various aqueous solutions
In: J. Eur. Ceram. Soc., Vol. 26, pp. 223-232, 2006.
5. Mitjan Kalin, Saša Novak, Jože Vižintin
Surface charge as a new concept for boundary lubrication of ceramics with water
In: J. phys., D, Appl. phys., Vol. 39, pp. 3138-3149, 2006.
6. Matej Komelj, Manfred Fähnle
Nonlinear magnetoelastic behavior of the bcc phases of Co and Ni: importance of third-order contributions for bcc Ni
In: Phys. rev., B, Condens. matter mater. phys., Vol. 73, pp. 012404-1-012404-4, 2006.
7. Matej Komelj, Daniel Steiauf, Manfred Fähnle
Influence of the substrate on the magnetic anisotropy of monatomic nanowires
In: Phys. rev., B, Condens. matter mater. phys., Vol. 73, pp. 134428-1-134428-5, 2006.
8. Massimiliano Liberatore, Franco Decker, Angela Šurca Vuk, Boris Orel, Goran Dražič
Effect of the organic-inorganic template ICS-PPG on sol-gel deposited V₂O₅ electrochromic thin film
In: Sol. energy mater. sol. cells, Vol. 90, No. 4, pp. 434-443, 2006.
9. Darja Lisjak, Paul J. McGuinness, Mihael Drofenik
Thermal instability of Co-substituted barium hexaferrites with U-type structure
In: J. mater. res., Vol. 21, pp. 420-427, 2006.
10. Darko Makovec, Zoran Samardžija, Mihael Drofenik
The solid solubility of holmium in BaTiO₃ under reducing conditions
In: J. Am. Ceram. Soc., Vol. 89, 10, pp. 3281-3284, 2006.
11. Paul J. McGuinness, David Jezeršek, Spomenka Kobe, Boštjan Markoli, Savo Spaić
100-micrometer-thick Nd-Fe-B magnets for MEMS applications produced via a low-temperature sintering route
In: J. magn. magn. mater., 2006.
12. Angelika Pretorius, M. Schowalter, Nina Daneu, Roland Kröger, Aleksander Rečnik, Andreas Rosenauer
Structural analysis of pyramidal defects in Mg-doped GaN
In: Phys. status solidi, C Curr. top. solid state phys. (Print), Vol. 3, pp. 1803-1806, 2006.
13. Evangelia Sarantopoulou, Zoe Kollia, Alciviadis-Constantinos Cefalas, Zoran Samardžija, Spomenka Kobe
Preparation of ultra-thin films of DNA bases with laser light at 157 nm
In: Thin solid films, Vol. 495, pp. 45-50, 2006.
14. Makoto Shiojiri, Miran Čeh, Sašo Šturm, C. C. Chuo, Jung-Tsung Hsu, J. R. Yang, Hiroshi Saijo
Structural and compositional analyses of a strained AlGaN/GaN superlattice
In: J. appl. phys., Vol. 100, pp. 03110-1-03110-7, 2006.
15. Angela Šurca Vuk, Robi Ješe, Miran Gabersček, Boris Orel, Goran Dražič
Structural and spectroelectrochemical (UV-vis and IR) studies of nanocrystalline sol-gel derived TiO₂ films
In: Sol. energy mater. sol. cells, Vol. 90, No. 4, pp. 452-468, 2006.
16. Manga Venkateswara Rao, Sašo Šturm, Fritz Phillipp, Matvei Zinkevich
XRD and TEM study of NiO-LSGM reactivity
In: Z. Met.kd., Vol. 97, pp. 789-793, 2006.
17. Thomas Walther, Frank Wolf, Aleksander Rečnik, Werner Mader
Quantitative microstructural and spectroscopic investigation of inversion domain boundaries in sintered zinc oxide ceramics doped with iron oxide: dedicated to professor dr. Knut Urban on the occasion of his 65th birthday
In: Z. Met.kd., Vol. 97, pp. 934-942, 2006.
18. F. Wetscher, R. Pippan, Sašo Šturm, F. Kauffmann, Christina Scheu, Gerhard Dehm
TEM investigations of the structural evolution in a pearlitic steel deformed by high-pressure torsion
In: Metall. mater. trans., A Phys. metall. mater. sci., Vol. 37A, pp. 1963-1968, 2006.

19. Nataša Zabukovec Logar, Nataša Novak Tušar, Gregor Mali, Matjaž Mazaj, Iztok Arčon, Denis Arčon, Aleksander Rečnik, Alenka Ristič, Venčeslav Kaučič
Manganese-modified hexagonal mesoporous aluminophosphate MnHMA: synthesis and characterization
In: Microporous and mesoporous materials, Vol. 96, No. 1/3, pp. 386-395, 2006.
20. Goran Dražič, Saša Novak, Janez Kovač
AEM and XPS of coated SiC particles: development of a material for a fusion-reactor application
In: Imaging microsc., Vol. 8, No. 3, pp. 36-37, 2006.
21. Paul J. McGuiness, David Jezeršek, Spomenka Kobe, Boris Saje
Microscale sintered magnets for MEMS type applications
In: Powder Metall., Vol. 49, pp. 15-17, 2006.
22. Medeja Gec, Miran Čeh
Tehnike priprave vzorcev za preiskave na TEM. 1. del, Mehanska predpriprava vzorca
In: Vakuumist, Vol. 26, No. 1-2, pp. 23-29, 2006.
23. Medeja Gec, Miran Čeh
Tehnike priprave vzorcev za preiskave na TEM. 2. del, Ionsko jedkanje vzorcev. Part 2, Ion beam thinning
In: Vakuumist, Vol. 26, No. 3, pp. 19-22, 2006.
24. Aleksander Rečnik
Rutile and Quarze von Krašnja in Slowenien
In: Miner.-Welt, Vol. 17, No. 6, pp. 22-36, 2006.
25. Aleksander Rečnik
Kristali rutila in kremenca iz alpskih razpok v grapah nad Krašnja
In: Proteus, Vol. 68, No. 6, pp. 246-260, feb. 2006.

REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Spomenka Kobe, Goran Dražič, Janez Stražisar, Alciviadis-Constantinos Cefalas
Magnetic water treatment device
In: Physikalische und Energetische Wasserbehandlungsverfahren für Wärmeübertrager und Rohrleitungen in der industriellen und gewerblichen Anwendung: Handbuch, D. Ende, ed., Essen, Publico Publications, 2006, pp. 94-100.
2. Uroš Herlec, Bojan Režun, Aleksander Rečnik, Feliks Poljanec
Rudišče živega srebra v Idriji
In: Mineralna bogastva Slovenije(Scopolia, Supplementum, 3), Miha Jeršek, ed., Ljubljana, Prirodoslovni muzej Slovenije, = Slovenian Museum of Natural History, 2006, pp. 15-27, 2006.
3. Uroš Herlec, France Stare, Aleksander Rečnik, Mirjan Žorž
Nastanek in značilnosti kremenovih in drugih kristalov pri Crngrobu
In: Mineralna bogastva Slovenije(Scopolia, Supplementum, 3), Miha Jeršek, ed., Ljubljana, Prirodoslovni muzej Slovenije, = Slovenian Museum of Natural History, 2006, pp. 348-355, 2006.
4. Polona Kralj, Mojca Bedjanič, Ludvik Penhofer, Aleksander Rečnik
Minerali bazaltnih tufov in tufitov pri Gradu na Goričkem
In: Mineralna bogastva Slovenije(Scopolia, Supplementum, 3), Miha Jeršek, ed., Ljubljana, Prirodoslovni muzej Slovenije, = Slovenian Museum of Natural History, 2006, pp. 363-365, 2006.
5. Vojko Pavčič, Aleksander Rečnik
Kristali kremenca z rožnato conarno rastjo z Zakladnika pri Bitnjah
In: Mineralna bogastva Slovenije(Scopolia, Supplementum, 3), Miha Jeršek, ed., Ljubljana, Prirodoslovni muzej Slovenije, = Slovenian Museum of Natural History, 2006, pp. 343-344, 2006.
6. Vili Rakovc, Renato Vidrih, Aleksander Rečnik
Igličasti kristali kremenca iz Zadobja
In: Mineralna bogastva Slovenije(Scopolia, Supplementum, 3), Miha Jeršek, ed., Ljubljana, Prirodoslovni muzej Slovenije, = Slovenian Museum of Natural History, 2006, pp. 302-303, 2006.
7. Aleksander Rečnik
Kalцит in markazit iz Šentjurja pri Celju
In: Mineralna bogastva Slovenije(Scopolia, Supplementum, 3), Miha Jeršek, ed., Ljubljana, Prirodoslovni muzej Slovenije, = Slovenian Museum of Natural History, 2006, pp. 187-190, 2006.
8. Aleksander Rečnik, Mirjan Žorž, Franc Golob, Vili Podgoršek
Minerali na trasi avtoceste med Vranskim in Lukovico

In: Mineralna bogastva Slovenije(Scopolia, Supplementum, 3), Miha Jeršek, ed., Ljubljana, Prirodoslovni muzej Slovenije, = Slovenian Museum of Natural History, 2006, pp. 393-395, 2006.

PUBLISHED CONFERENCE PAPERS

Invited Paper

1. Miran Čeh, Sašo Šturm, Hui Gu, Makoto Shiojiri
Qualitative and quantitative interpretation of atomic-resolution HAADF-STEM images
In: Proceedings, 2nd Croatian Congress on Microscopy with International participation, May 18-21, 2006, Topusko, Croatia, Srećko Gajović, ed., Zagreb, Croatian Society for Electron Microscopy, 2006, pp. 53-54.

Regular Papers

1. Saša Novak, Milan Čerček
Alternativni viri energije: fuzija
In: SLOTRIB '06: Proceedings, Conference on Fuels, Tribology and Ecology, Ljubljana, Slovenia, 14. november 2006, Jože Vižintin, ed., Janez Bedenk, ed., Mitjan Kalin, ed., Ljubljana, Slovensko društvo za tribologijo, 2006, pp. 19-30.
2. Saša Novak, Goran Dražič, Katja Mejak
Electrophoretic deposition of green parts for LPS SiC-based ceramics
In: Proceedings of the 2nd international conference on electrophoretic deposition: fundamentals and applications: May 29 - June 2, 2005, Castelvecchio Pascoli (near Barga), Italy (Key engineering materials, Vol. 314, 2006), Aldo R. Boccaccini, ed., Aedermansdorf, Trans Tech Publications, 2006, Vol. 314, pp. 45-50, 2006.
3. Saša Novak, Katja Mejak, Goran Dražič
The preparation of LPS SiC-fibre-reinforced SiC ceramics using electrophoretic deposition
In: 2nd International Conference on Electrophoretic Deposition: Fundamentals and Application: June 2005, Barga, Italy (Journal of Materials Science, Vol. 41, No. 24, 2006), Aldo R. Boccaccini, ed., London, Chapman and Hall, 2006, pp. 8093-8100.
4. Zoran Samardžija
Quantitative EPMA analyses of (1-x)Pb(Mg_{1/3}Nb_{2/3})O₃ × xPbTiO₃ ceramics: problems and solutions
In: Proceedings, 2nd Croatian Congress on Microscopy with International participation, May 18-21, 2006, Topusko, Croatia, Srećko Gajović, ed., Zagreb, Croatian Society for Electron Microscopy, 2006, pp. 114-115.
5. Thomas Walther, Aleksander Rečnik, Nina Daneu
A novel method of analytical transmission electron microscopy for measuring highly accurately segregation to special grain boundaries or planar interfaces
In: Modern developments and applications in microbeam analysis: proceedings of the 9th Workshop of the European Microbeam Analysis Society (EMAS) and the 3rd Meeting of the International Union of Microbeam Analysis Society (IUMAS), May 22-26, 2005 (Microchimica acta, vol. 155, no. 1-2, 2006), Wien, Springer, 2006, pp. 313-318.

THESES

B. Sc. Theses

1. David Jezeršek, 100- μ m-thick Nd-Fe-B sintered magnets for MEMS applications (Asst. Prof. Milan Bizjak, Prof. Spomenka Kobe)
2. Saša Rustja, The influence of binary phases from the BaO-Bi₂O₃ system on microstructure development of the ZnO ceramics (Prof. Stane Pejovnik, Dr. Slavko Bernik)
3. Nataša Drnovšek, Preparation of the silicon carbide based material suitable for fusion reactor applications (Prof. Stane Pejovnik, Asst. Prof. Saša Novak)

PATENT APPLICATION

1. Saša Novak, Katja Mejak, Stojana Veskovič Bukudur, Hydrophobisation of ceramic powder by organic coating in aqueous suspension: Patent application No.: 200600004, Ljubljana, Slovenian Intellectual Property Office, Ljubljana, Slovenia, 2006.

INTERNATIONAL PROJECTS

1. 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 Krmptič
2. Enabling Science and Technology through European Electron Microscopy
ESTEEM
6. FP; 026019

EC; Prof. Gustaaf Van Tendeloo, Universiteit Antwerpen, Antwerpen, Belgium
Asst. Prof. Miran Čeh

3. Complex Metallic Alloys
CMA
6. FP
NMP3-CT-2005-500140
EC; Centre National de la Recherche Scientifique, Paris, France
Prof. Spomenka Kobe, Prof. Janez Dolinšek, Dr. Peter Panjan
4. Gas Impermeable Coatings for SiC/SiC - UT1
EURATOM - MHEST
SICOAT
6. FP, EURATOM, Slovenian Fusion Association - SFA
FU06-CT-2004-00083, 3211-05-000017

- EC, RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Asst. Prof. Saša Novak Krmpotič, Asst. Prof. Goran Dražič
5. Novel Processing of SiC/SiC by Vacuum Slip-Infiltration of SiC Fibre Preforms - UT2
EURATOM - MHEST
SIC-VSI
6. FP, EURATOM, Slovenian Fusion Association - SFA
FU06-CT-2004-00083, 3211-05-000017
EC, RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Asst. Prof. Goran Dražič, Asst. Prof. Saša Novak Krmpotič
 6. Strengthening the Role of Women Scientists in Nano-Science
WOMENINANO
6. FP
SAS6, 016754
EC, Dr. Annett Gebert, IFW Dresden, Leibniz-Institut für Festkörper- und
Werkstoffforschung Dresden E.V., Dresden, Germany
Prof. Spomenka Kobe
 7. Slovenian Fusion Association, Public Information
EURATOM - MHEST
6. FP, EURATOM, Slovenian Fusion Association - SFA
FU06-CT-2004-00083, 3211-05-000017
EC, RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Asst. Prof. Saša Novak Krmpotič
 8. Fuel Storage Nano-Composites Fabricated by Pulse Laser Deposition - PLD
BI-GR-04-06-019
Prof. A. C. Cefalas, National Hellenic Research Foundation, Theoretical and Physical
Chemistry Institute, Athens, Greece
Prof. Spomenka Kobe
 9. Hydrogen Storage in Ni-Ti-Zr-Hf Quasicrystals
BI-HR/06-07-020
Dr. Muhamed Sućeska, Dr. Maša Rajič Linarić, Brodarski Institute, Laboratory for
thermal analyses, Zagreb, Croatia
Dr. Paul McGuinness
 10. Precipitation of Calcium Carbonate in the Magnetic Field
BI-HR/05-06-031
Dr. Sc. Damir Kralj, Rudjer Boskovic Institute, Zagreb, Croatia
Prof. Spomenka Kobe
 11. Study of Remodelling of Bone-ceramic Interface to Assess Cell Growth Kinetics as a
Function of Composition and Morphological Modification of Ceramic Implant
BI-IN/06-07-009
Prof. Basu Debabrata, Central Glass & Ceramic Research Institute, Calcutta, India
Dr. Nina Daneu
 12. Controlled Processing of ZnO Based Varistor Ceramics
SLO-JPN
Dr. Toshiyuki Isshiki, Kyoto Institute of Technology, Faculty of Engineering and Design,
Dept. Electronics & Information Science, Matsugasaki, Sakyo-ku, Kyoto, Japan
Dr. Nina Daneu
 13. IMAGE-WARP: Processing of Atomic-Resolution HAADF-STEM Images
SLO-JPN
Dr. Hiroshi Saijo, Kyoto Institute of Technology, Faculty of Engineering and Design,
Dept. Electronics & Information Science, Matsugasaki, Sakyo-ku, Kyoto, Japan
Dr. Aleksander Rečnik
 14. Electronic Ceramics with Interface Control of Electrical Properties
BI-CN/05-07/006
Prof. Hui Gu, Shanghai Institute of Ceramics, Shanghai, China
Asst. Prof. Miran Čeh
 15. Environmental Hydrogen-based Recycling of Nd-Fe-B Magnets
BI-CN/05-07/008
Dr. Gaolin Yan, Harbin Institute of Technology, ShenZhen Graduate School, HIT
Campus of ShenZhen University Town, XiLi, ShenZhen, China
Dr. Paul McGuinness
 16. Low Pressure Injection Molding of Near-Net Shaped Piezoelectric Ceramics
U3-MM/K6-06-028
Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials
Group, Sangnam-Dong, Changwon, Korea
Asst. Prof. Miran Čeh, Prof. Tomaž Kosmač
 17. Interface Analysis of Piezoelectric Ceramic Materials
U3-MM/K7-05-015
Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials
Group, Sangnam-Dong, Changwon, Korea
Asst. Prof. Miran Čeh
 18. Novel Possibilities for the Processing of ZnO - Based Varistor Ceramics
BI-PL/04-05-009
Dr. Witold Mielcarek, Electrotechnical Institute - IEL, Wrocław, Poland
Dr. Slavko Bernik
 19. Orientation Imaging Microscopy and Microanalysis Applied to Advanced Materials
BI-PL/04-05-010
Dr. Marek Faryna, Polish Academy of Sciences, Institute of Metallurgy and Materials
Science, Krakow, Poland
Asst. Prof. Goran Dražič
 20. Improved Materials Processing Through Tailoring the Surface Characteristics of Nano-
and Micro Sized Powders
BI-PT-04-06-016
Prof. Jose Maria Ferreira, Universidade de Aveiro, Department of Ceramics and Glass
Engineering, Aveiro, Portugal
Asst. Prof. Saša Novak Krmpotič
 21. Development of Varistor Ceramics with Reduced Amount of Dopants and Improved
Microstructural and Electrical Characteristics
BI-SCG/05-06-009
Dr. Zorica Branković, Center for Multidisciplinary Studies of the Belgrade University,
Belgrade, Serbia and Montenegro
Dr. Slavko Bernik
 22. Development of Single Crystalline and Electroceramic Materials by Sintering Process
BI-TR/05-08-002
Prof. Mehmet Ali Gülgün, Sabanci University, Orhanli Tuzla, Istanbul, Turkey
Asst. Prof. Miran Čeh
 23. Texturing and Characterisation of ZnO-based Ceramics
BI-TR/05-08-003
Prof. Ender Suvaci, Anadolu University, Department of Materials Science and
Engineering, Iki Eylus Campus, Eskisehir, Turkey
Dr. Slavko Bernik
 24. A Hydrogen-storage Device for Low-cost, Environmentally Friendly Transportation
PSP
BI-GB/06-010
Prof. Ivor Rex Harris, The University of Birmingham, School of Metallurgy and
Materials, Birmingham, Great Britain
Dr. Paul McGuinness, Prof. Spomenka Kobe

R & D GRANTS AND CONTRACTS

1. Layered ceramic nanostructures and 2D nanoparticles arrays
Asst. Prof. Miran Čeh
2. Fabrication of novel thin films by pulsed-laser ablation with in situ ICP-MS analysis of
target plumes for deposition control
Prof. Spomenka Kobe
3. Nanostructural engineering of semiconducting materials
Dr. Aleksander Rečnik
4. A development of low-activation material for the first wall in fusion reactor
Asst. Prof. Saša Novak Krmpotič
5. Nanostructural investigations of special boundaries in minerals
Dr. Nina Daneu, Prof. Tadej Dolenc
6. Qualitative Z-contrast microscopy of functional ceramics
Prof. Spomenka Kobe, Dr. Sašo Šturm
7. Hard magnetic Co-Pt thin films produced with electrodeposition
Prof. Spomenka Kobe, Dr. Kristina Žužek Rožman
8. Exploration and preservation of Slovenian mineralogical heritage
Dr. Aleksander Rečnik
9. Application of new technologies to prevent scaling in industrial flow systems
Prof. Spomenka Kobe
10. Rare-earth-transition-metal alloys for high-energy permanent magnets and metal-
hydride batteries
Dr. Paul McGuinness
11. Research of degradation mechanisms and improvement of properties of metallized film
capacitors
Asst. Prof. Miran Čeh
12. Development of tissue engineered bone for use in periodontology, traumatology and
orthopaedic surgery
Asst. Prof. Miran Čeh
13. Development of Graetzl-type photo-electrochemical cells
Asst. Prof. Goran Dražič
14. New generation of elements and devices for protection against transient surges (CoE
Materials for electronics of next generation and other emerging technologies)
Dr. Slavko Bernik
15. Magnetic materials and intermetallic alloys (CoE Materials for electronics of next
generation and other emerging technologies)
Prof. Spomenka Kobe
16. Nanostructured surfaces and interfaces (CoE Nanosciences and nanotechnologies)
Asst. Prof. Goran Dražič
17. Characterization on the nanometric scale (CoE Nanosciences and nanotechnologies)
Asst. Prof. Miran Čeh

RESEARCH PROGRAM

1. Nanostructured materials
Prof. Spomenka Kobe

NEW CONTRACTS

- Analytical electron microscopy of metallic samples
Faculty for Natural Sciences, University of Ljubljana
Asst. Prof. Goran Dražič
- Cooling systems based on magneto-caloric effect
PROKOL d.o.o. Idrija
Prof. Spomenka Kobe
- Rare-earth-transition-metal alloys for high-energy permanent magnets and metal-hydride batteries
Magnetni, d. d., Ljubljana
Dr. Paul McGuinness
- Application of new technologies to prevent scaling in industrial flow systems
Termoelektrarna-Toplarna, d.o.o., Ljubljana
Prof. Spomenka Kobe
- Dual energy varistor for impulse currents
Varsi, d.o.o., Ljubljana
Dr. Slavko Bernik
- Exploration and preservation of Slovenian mineralogical heritage
Mežica Lead and Zinc Mine, Mežica; Idrija Mercury Mine, Idrija, Slovenian Museum of National History, Ljubljana
Dr. Aleksander Rečnik

VISITORS FROM ABROAD

- Lorraine Neale, University of Birmingham, Birmingham, United Kingdom, 29 January - 1 February 2006
- Werner Rechberger, M.Sc., Technische Universität Graz, Graz, Austria, 12-25 February 2006
- Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials - KIMM, Changwon-city, Kyeongnam, South Korea, 1-4 March 2006
- Prof. Isao Tanaka, Kyoto Institute of Technology, Kyoto, Japan, 23-25 April 2006
- Prof. Constaninos Cefalas, National Hellenic Foundation - NHRF, Theoretical and Physical Chemistry Institute, Athens, Greece, 3-7 May 2006
- Dr. Christina Scheu, Gert Gassner, Montanuniversität Leoben, Leoben, Austria, 8-10 May 2006
- Prof. Hui Gu (10-17 May 2006) and Xian-Hao Wang (10 May - 6 June 2006), Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China
- Prof. Jose Maria Ferreira, Universidade de Aveiro, Aveiro, Portugal, 23-30 June 2006
- Dr. Goran Branković, Dr. Zorica Branković, Centar za multidisciplinarne studije, Univerzitet u Beogradu, Belgrade, Serbia, 28 June - 3 July 2006
- Dr. Maša Rajič Linarič, Dr. Davor Linarič, Brodarski institute, Zagreb, Croatia, 3 July 2006
- Katarina Vojisavljević, Milan Žunić (7-18 August 2006) and Katarina Djuriš, (7 August - 1 September 2006), Centar za multidisciplinarne studije, Univerzitet u Beogradu, Belgrade, Serbia
- Jerika Suely Lamas, Faculdade de Engenharia Quimica de Lorena, São Paulo, Brazil, 6 July - 31 August 2006
- Prof. Ivor R. Harris, University of Birmingham, Birmingham, United Kingdom, 7-10 October 2006
- Dr. Wilfried Sigle, Rainer Höschel, Max-Planck-Institut für Metallforschung, Stuttgart, Germany, Christian Dietl, Karl Zeiss, Oberkochen, Germany, 5-8 November 2006
- Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials - KIMM, Changwon-city, Kyeongnam, South Korea, 7-16 December 2006
- Dr. Borianna Rashkova, Erich Schmid Institut für Materialwissenschaft, Montanuniversität Leoben, Österreichische Akademie der Wissenschaften, Leoben, Austria, 12-15 December 2006

STAFF

Researchers

- Dr. Slavko Bernik**
- Asst. Prof. Miran Čeh**
- Asst. Prof. Goran Dražič**
- Prof. Spomenka Kobe**, Head**
- Dr. Matej Komelj**
- Dr. Paul John McGuinness
- Asst. Prof. Saša Novak Krmpotič**
- Dr. Aleksander Rečnik**
- Dr. Sašo Šturm

Postdoctoral associates

- Dr. Nina Daneu
- Dr. Vesna Šrot

- Dr. Kristina Žužek Rožman

Postgraduates

- Nataša Drnovšek, B. Sc.
- Andraž Kocjan, B. Sc.
- Katja Mejak, B. Sc.
- Tea Toplišek, B. Sc.
- Kristina Žagar, B. Sc.

Technical officers

- Medeja Gec, B. Sc.
- David Jezeršek, B. Sc.
- Matejka Podlogar, B. Sc.
- Benjamin Podmiljšak, B. Sc.
- Zoran Samardžija, B. Sc.
- Sanja Fidler, B. Sc.

** Part-time faculty member