DEPARTMENT FOR NANOSTRUCTURED MATERIALS K-7

Head:
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The basic research in the Department for Nanostructured Materials focuses on inorganic materials whose specific physical properties are a consequence of their structural and chemical characteristics at the nanometre and atomic levels. It includes experimental and theoretical investigations of structures, analysis of chemical composition at the atomic level, and measurement and calculation of physical properties, all of which enable us to tailor the final properties during the preparation of micro- and nanostructured materials. The research involves natural and manufactured ceramic materials as well as metals and intermetallic alloys.

Over the last year we have investigated the hydrogen disproportionation reaction for a range of Nd–Fe–B- and Sm–Fe-based alloys using a modified vibrating-sample magnetometer (VSM) that can operate in a hydrogen atmosphere at temperatures up to 1000 °C. The results were compared with models used to describe transformation phenomena, e.g., the JMA model. The progress of the disproportionation reaction was found to depend on the temperature and the composition of the alloy. Ternary Sm–Fe–Ta materials were found to disproportionate more slowly than the binary materials, and the rate of transformation was found to be closely related to the amount of untransformed material remaining during the reaction. The Nd–Fe–B-based materials disproportionated at higher temperatures and produced data that suggest that the JMA model is inappropriate for these alloys.

Sm–Fe thin films with thicknesses of 10–50 nm were deposited on a Si wafer coated with an approximately 150 nm thick layer of Ta by ablating a solid $Sm_{13.7}Fe_{86.3}$ target. The Sm–Fe was ablated using a molecular fluorine laser with a wavelength of 157 nm. The composition of the nanocrystals in Fe and Sm remains the same as the initial target composition, in contrast to growth using pulsed-laser deposition (PLD) at longer wavelengths. For Magnequench, USA, we investigated hot-pressed die-upset-forged Nd–Fe–B-type Ga-containing samples, using high-temperature magnetic measurements as well as SEM and HRTEM. The results confirmed the benefits of Pr substitutions and Ga additions in terms of high-temperature magnetic properties. Ga was also shown to concentrate at the grain boundaries in a sub-nanometre layer. Structural analyses based on X-ray diffraction, together with scanning and transmission electron microscopy studies, were used to characterise quasicrystalline-related samples based on Al–Cr–Fe and Al–Pd–Mn. We also investigated the properties of modern magnetic materials that are interesting from the point of view of basic research and which are technologically promising. The investigations were based on realistic simulations within the framework of density functional theory and its improvements. We have developed and implemented our own version of the LDA+U method, which is devoted to a description of the correlated electrons that are present in magnetic oxides, actinides and lanthanides, and in systems with reduced dimensionality. The results of our application-oriented research on the influence of magnetic water-treatment on the nucleation and further crystallization of $CaCO_3$ resulted in an invited talk in the life science section at an international conference on magnetism. Using quantitative X-ray analyses it was shown that the calcite/aragonite ratio, which is 90/10 in a non-treated system, changes to 29/71 in a treated one, and this has a substantial ecological impact. In a bilateral collaboration with our co-workers, NHRF Athens, we proposed a model that offers an explanation of this phenomenon. With co-workers from the University of Florida we investigated the improved flow properties of coated Nd–Fe–B powders. The results of this study showed a 20 % improvement, which is an important increase for industrial applications.

Using dedicated analytical electron microscopy the presence of nanometre-sized clusters of Tm atoms inside a CaF_2 monocrystal matrix was investigated. An energy-dispersive X-ray spectroscopy study using electron beams of various sizes indicated the presence of inhomogeneous regions of the order of a few nanometres. With high-resolution transmission electron microscopy we found areas with non-uniform contrast. Simulated high-resolution transmission electron microscopy (HRTEM) images were calculated for a model structure where one row of Ca atoms was replaced with Tm atoms. A comparison of simulated and experimental HRTEM images suggested the possible existence of clusters. This was finally confirmed by using high-angle annular dark-field microscopy, where the clusters were imaged at atomic resolution.

In the field of semiconducting ZnO ceramics and ZnO-based varistor ceramics we studied the influence of selected dopants on ZnO grain growth and microstructure development. The main focus was on the influence of inversion boundaries (IBs) (special grain boundaries that form in practically every grain of ZnO ceramic doped with Sb_2O_3 or some other dopants) on the

A new mechanism for the growth of ZnO grains with inversion boundaries has been determined. This mechanism allows us to tailor the development of microstructures in varistor ceramics.
HRTEM and HAADF-STEM were used to determine the layer thickness in $Al_{0.14}Ga_{0.86}N$/GaN superstructures, which are an integral part of GaN-based violet laser diodes.
NATO SfP and HITEMAG (5FP) projects were successfully completed, and have led to the production of bonded Nd-Fe-B magnets and a EP for a high-temperature measuring device.
A new method that uses insitu magnetic measurements with a VSM was developed to follow the kinetics of hydrogen-induced transformation processes.

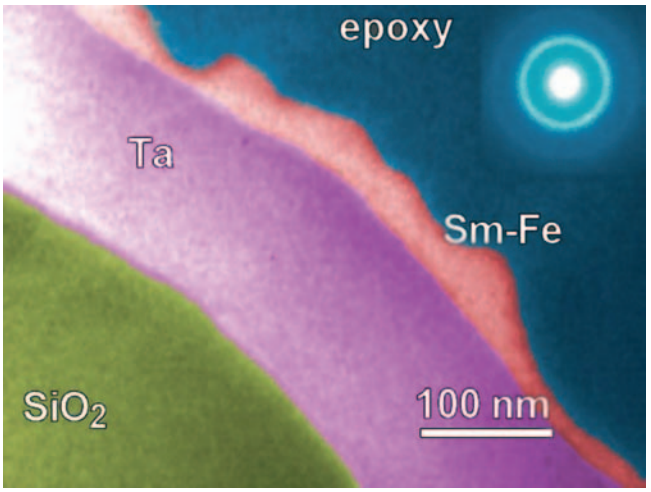

Figure 1: Dark-field TEM micrograph of a cross-section of the Sm-Fe thin film deposited by PLD at 157 nm on a Ta/Si substrate. Ta and Sm-Fe layers are amorphous (inset is the selected area electron diffraction (SAED) pattern of both layers).

exaggerated grain growth, and on the possibility of controlling their nucleation and hence the final size of the ZnO grains with added Sb_2O_3. We investigated alternatives to the conventional doping and processing of ZnO-based varistor ceramics that would enable us to significantly reduce the amounts of added dopants, in order to obtain "simplified" varistor microstructures with fewer secondary phases. We also looked at the influence of specific dopants, like Al, which significantly influence the electrical characteristics of varistor ceramics when used in very low, ppm, concentrations. In collaborations with domestic and foreign partners, different types of ZnO-based varistors were developed. Within the 5th FP of the EC CRAFT project VARESTER we participated in a collaboration with VARSI, Ljubljana and Université Paul Sabatier to develop 30%-miniaturized high-voltage (9kV) varistor blocks, which will be active elements in new, miniaturized, high-voltage surge arresters developed within the project by MECOM, Ljubljana, Peirs, Italy, and the Electrotechnical Institute Wrocław, Poland. In collaboration with VARSI, various types of energy varistors were developed to meet the needs of Iskra Zaščite, Ljubljana, to realize a new generation of miniaturized and integrated surge-protection devices (SPDs) for voltage protection. We also participated with VARSI and ETI, Izlake in the development of a new protection element that will integrate the functions of a classical current fuse with the voltage protection of a varistor – the so-called integrated varistor. The variations in the intensity ratios between the atomic columns in the perovskites $CaTiO_3$ and $SrTiO_3$, which are due to distorted crystal structures and/or the incorporation of foreign atoms into the crystal lattice, were studied by Z-contrast microscopy (high-angle annular-dark field-scanning transmission electron microscopy – HAADF-STEM). We found that the intensities are largely dependent on local lattice distortions and that they should be included in HAADF-STEM simulations in order to obtain the correct results in quantitative HAADF-STEM. In cooperation with the University of Oxford we developed a method for the geometry restoration of distorted atomic-resolution scanning–transmission electron microscopy images. Distortions that are the result of environmental instabilities during scanning over the specimen are difficult to avoid and therefore the images are not useful for a proper quantitative evaluation unless the distortions are corrected. With the so-called IMAGE-WARP method this problem has been successfully solved.

The chemistry of planar faults in macroscopically twinned natural sphalerite crystals was studied by energy-dispersive X-ray spectroscopy (EDS) and electron-energy-loss spectroscopy (EELS). According to our EDS results the segregation of Cu along the twin boundaries has been related to the precipitation of chalcopyrite ($CuFeS_2$) grains. A significant decrease in the amount of sulphur when approaching the twin boundary is accompanied by an increase in the oxygen concentration. To further examine the presence of oxygen we also performed EELS analyses, which confirmed our EDS data. The replacement of S^{2-} with O^{2-} is possible due to their similar electronic configurations and this stabilizes the local hexagonal stacking. Therefore, the increase in the oxygen concentrations can be understood as the main reason for the formation of twin boundaries in sphalerite crystals. HRTEM and HAADF-STEM were used to determine the layer thickness in the superstructure $Al_{0.14}Ga_{0.86}N$/GaN, which is an integral part of GaN-based violet laser diodes. In order to determine the thickness of the layers with high precision we developed appropriate algorithms and image-processing techniques. Each individual layer in the superstructure, which cannot be distinguished by HRTEM, contains nine lattice planes in the GaN [0001] direction. With Bosch we continued to develop a $Sr(Ti,Fe)O_3$-based oxygen sensor. We found that iron readily incorporates into the perovskite matrix, creating an oxygen-deficient solid solution. However, planar faults in the perovskite grains were also observed. In 2003 the Group for Electron Microscopy carried out electron microscopy analyses of inorganic and organic materials for the following customers: the Jožef Stefan Institute (F5, F3, K3, O2), the National Institute of Chemistry, the Faculty of Pharmacy, the Faculty for Natural Sciences, the Faculty of Chemistry and Chemical Technology, Valdoltra Hospital, Lek, Krka, Donit Tesnit, BIA Separations, EMO Kemija, Cinkarna Celje, Metalflex, ETRA and Ocvirk Jože s.p.

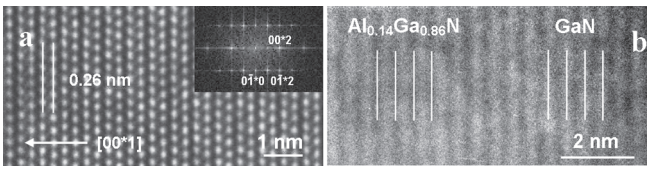

Figure 2: (a) Experimental HRTEM image of SLS superstructure taken in the [10*0] zone axis. No difference can be distinguished between the GaN and $Al_{0.14}Ga_{0.86}N$ layers. (b) Experimental HAADF-STEM image of the SLS region from Figure 1. The bright and dark layers correspond to GaN and $Al_{0.14}Ga_{0.86}N$, respectively.

Some outstanding publications in the year 2003

1. N. Daneu, A. Rečnik, S. Bernik, Grain growth control in Sb_2O_3-doped ZnO, J. Am. Ceram. Soc., 86 (2003), 1379-1384.
2. P. J. McGuiness, K. Žužek, B. Podmiljšak, S. Kobe, Magnetic monitoring of the hydrogenation-decomposition-desorption-recombination process in SmFe-based alloys, J. Appl. Phys., 93 (2003), 6981-6920
3. C. Ederer, M. Komelj and M. Faehnle, Magnetism in systems with various dimensionality, A comparison between Fe and Co, Phys. Rev, B 68 (2003), 52402
4. S. Kobe, G. Dražić, P. J. McGuiness, A. Meden, E. Sarantopoulou, Z. Kollia, A. C. Cefalas, Control over nanocrystallization in turbulent flow in the presence of magnetic fields, Mater. sci. eng., C, Biomim. Mater., Sens. Syst., 23 (2003), 811-815
5. M. Čeh, S. Šturm, A. Rečnik, HAADF STEM imaging of planar faults in nonstoichiometric $CaTiO_3$, Mater. sci. forum, 413 (2003), 11-16

BIBLIOGRAPHY

ORIGINAL ARTICLES

1. Andreja Benčan, Goran Dražić, Marko Hrovat, Janez Holc, Marija Kosec
   Electrical properties and chemical compatibility of PZT thick film on Ni substrates
   In: J. Mater. Sci., Vol. 38, pp. 3769-3774, 2003.
2. Slavko Bernik, Ryna B. Marinenko, Janez Holc, Zoran Samardžija, Miran Čeh, Marija Kosec
   Compositional homogeneity of ferroelectric (Pb,La)(Ti,Zr)O_3 thick films
   In: J. mater. res., Vol. 18, pp. 515-523, 2003.
3. Philippe Boullay, D. Mercurio, Andreja Benčan, Anton Meden, Goran Dražić, Marija Kosec
   An XRPD ab-initio structural determination of La_2RuO_5
   In: J. solid state chem., Vol. 170, pp. 294-302, 2003.
4. Romana Cerc Korošec, Peter Bukovec, Boris Pihlar, Angela Šurca Vuk, Boris Orel, Goran Dražić
   Preparation and structural investigations of electrochromic nanosized NiO_x films made via the sol-gel route
   In: Solid state ion., Vol. 165, no. 1/4, pp. 191-200, 2003.
5. Miran Čeh, Sašo Šturm, Aleksander Rečnik
   HAADF STEM imaging of planar faults in nonstoichiometric $CaTiO_3$
   In: Mater. sci. forum, Vol. 413, pp. 11-16, 2003.
6. Nina Daneu, Aleksander Rečnik, Slavko Bernik
   Grain growth control in Sb_2O_3-doped ZnO
   In: J. Am. Ceram. Soc., Vol. 86, pp. 1379-1384, 2003.
7. Claude Ederer, Matej Komelj, James W. Davenport, Manfred Fähnle
   Comment on the analysis of angle-dependent X-ray magnetic circular dichroism in systems with reduced dimmensionality
   In: J. electron spectrosc. relat. phenom., Vol. 130, pp. 97-100, 2003.
8. Claude Ederer, Matej Komelj, Manfred Fähnle
   Magnetism in systems with various dimensionalities: a comparison between Fe and Co
   In: Phys. rev., B, Condens. matter mater. phys., Vol. 68, pp. 052402-1-052402-4, 2003.
9. Oliver Gutfleisch, K. Khlopkov, A. Teresiak, Karl-Hartmut Müller, Goran Dražić, Chisato Mishima, Yoshinobu Honkura
   Memory of texture during HDDR processing of NdFeB
   In: IEEE trans. magn., Vol. 39, pp. 2926-2931, 2003.
10. Marko Hrovat, Andreja Benčan, Darko Belavič, Janez Holc, Goran Dražić
    The influence of firing temperature on the electrical and microstructural characteristics of thick-film resistors for strain gauge applications
    In: Sens. actuators, A, Phys., Vol. 103, pp. 341-352, 2003.
11. Boštjan Jančar, Danilo Suvorov, Matjaž Valant, Goran Dražić
    Characterization of $CaTiO_3$-$NdAlO_3$ dielectric ceramics
    In: J. Eur. Ceram. Soc., Vol. 23, pp. 1391-1400, 2003.
12. Martin Klanjšek, Peter Jeglič, Paul J. McGuiness, M. Feuerbacher, E. S. Zijlstra, J. M. Dubois, Janez Dolinšek
    Structural perfection and the electrical and magnetic responses of icosahedral AlPdMn quasicrystals
    In: Phys. rev., B, Condens. matter mater. phys., Vol. 68, pp. 134210-1-134210-9, 2003.
13. Spomenka Kobe, Goran Dražić, Paul J. McGuiness, Anton Meden, Evangelia Sarantopoulou, Zoe Kollia, Alciviadis-Constantinos Cefalas
    Control over nanocrystalization in turbulent flow in the presence of magnetic fields
    In: Mater. sci. eng., C, Biomim. mater., sens. syst., Vol. 23, pp. 811-815, 2003.
14. Paul J. McGuiness, Benjamin Podmiljšak, Spomenka Kobe
    The effect of Pr and Zr substitutions on the disproportionation reaction in NdFeB-based materials
    In: IEEE trans. magn., Vol. 39, pp. 2956-2958, 2003.
15. Paul J. McGuiness, Kristina Žužek, Benjamin Podmiljšak, Spomenka Kobe
    Magnetic monitoring of the hydrogenation-decomposition-desorption-recombination process in SmFe-based alloys
    In: J. appl. phys., Vol. 93, pp. 6981-6920, 2003.
16. M. Očko, Dj. Drobac, J.-G. Park, Zoran Samardžija, K. Zadro
    Investigation of the spin glass transition in a low U doped YRu_2Si_2 sample
    In: J. phys., Condens. matter, Vol. 15, pp. 4613-4621, 2003.
17. Zoran Samardžija, Ryna B. Marinenko, Slavko Bernik, Marija Kosec, Miran Čeh
    Determination of the chemical composition and heterogeneity range of highly dense PLZT ceramics by electron-probe microanalysis
    In: Mater. tehnol., Vol. 37, pp. 3-7, 2003.
18. E. Sarantopoulou, Zoran Samardžija, Spomenka Kobe, Z. Kollia, Alciviadis-Constantinos Cefalas
    Removing foxing stains from old paper at 157 nm
    In: Appl. surf. sci., Vol. 208-209, pp. 311-316, 2003.
19. Evangelia Sarantopoulou, Spomenka Kobe, Zoe Kollia, Paul J. McGuiness, Alciviadis-Constantinos Cefalas
    Magnetic moment of the $4f^8$ and $4f^75d$ electronic configuration of Tb^{3+} ions in wide band gap fluoride dielectric crystals
    In: IEEE trans. magn., Vol. 39, pp. 3426-3428, 2003.
20. Evangelia Sarantopoulou, Spomenka Kobe, Zoe Kollia, Benjamin Podmiljšak, Paul J. McGuiness, Goran Dražić, Alciviadis-Constantinos Cefalas
    Magnetic and optical properties of single $4f^n$ and mixed $4f^{n-1}5d$ electronic configurations of trivalent rare earth ions in wide band gap dielectric crystals
    In: J. magn. magn. mater., Vol. 267, pp. 182-190, 2003.
21. Evangelia Sarantopoulou, Zoe Kollia, Klemen Kočevar, Igor Muševič, Spomenka Kobe, Goran Dražić, E. Gogolides, P. Argitis, Alciviadis-Constantinos Cefalas
    The challenges of 157 nm nanolithography: surface morphology of silicon-based copolymers
    In: Mater. sci. eng., C, Biomim. mater., sens. syst., Vol. 23, pp. 995-999, 2003.
22. Nataša Stojić, James W. Davenport, Matej Komelj, James Glimm
    Surface magnetic moment in α-uranium by density-functional theory
    In: Phys. rev., B, Condens. matter mater. phys., Vol. 68, pp. 094407-1-094407-5, 2003.
23. Vesna Šrot, Aleksander Rečnik, Breda Mirtič, Tadej Dolenec
    Značilnosti kristalov fluorita s severnih pobočij Blegoša
    In: RMZ-mater. geoenviron., Vol. 50, no. 2, pp. 467-483, 2003.
24. Vesna Šrot, Aleksander Rečnik, Christina Scheu, Sašo Šturm, Breda Mirtič
    Stacking faults and twin boundaries in sphalerite crystals from the Trepča mines in Kosovo
    In: Am. mineral., Vol. 88, pp. 1809-1816, 2003.
25. Kristina Žužek, Paul J. McGuiness, Spomenka Kobe
    Magnetic monitoring of the nitriding process in Sm-Fe-Ta-based alloys
    In: IEEE trans. magn., Vol. 39, 2983-2985, 2003.
26. Kristina Žužek, Paul J. McGuiness, Spomenka Kobe
    Magnetic monitoring of the gaseous interactions in the Sm-Fe-Ta- based alloys
    In: Mater. tehnol., Vol. 37, pp. 33-37, 2003.
27. Paul J. McGuiness
    Technical english
    In: Mostovi (Ljublj.), Let. 36, No. 1, pp. 53-58, 2003.

PUBLISHED CONFERENCE PAPERS

Published Invited Conference Papers

1. Nina Daneu, Aleksander Rečnik, Thomas Walther, Werner Mader
   Atomic structure of basal-plane inversion boundaries in SnO_2-doped ZnO: invited talk presented at 31st Microscopy Conference 2003, September 7-12, Dresden, Germany
   In: Microsc. microanal. (Print), Vol. 9, suppl. 3, pp. 286-287, 2003.
2. Goran Dražić
   Exploring the world of microstructure - from bulk to atoms
   In: [Conference notes], Processing of Electroceramics Symposium, August 31st - September 3rd, 2003 Bled, Slovenia, Marija Kosec, ed., Danjela Kuščer Hrovatin, ed., Barbara Malič, ed., Ljubljana, Jožef Stefan Institute, 2003, pp. 69-81.
3. Matej Komelj, Claude Ederer, Manfred Fähnle
   The electron theory of magnetism in monatomic nanowires
   In: Advances in solid state physics. volume 43: [presented at Metallic Nanowires at DPG spring meeting for Solid State Physics, 24-28 2003, Dresden], Bernhard Kramer, ed., Berlin [etc.], Springer, 2003, pp. 781-788.
4. Aleksander Rečnik, Günter Möbus, Sašo Šturm
   Real-space processing of scanning transmission electron microscopy images
   In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 73-74.

Published Conference Papers

1. Andreja Benčan, Marija Kosec, Janez Holc, Goran Dražić, Marko Hrovat
   Some characteristics of conductive lanthanum ruthenates: presented at COST 525 meeting held in Aveiro, Portugal, October 2001
   In: Br. ceram. proc., pp. 81-92.
2. Slavko Bernik, Zoran Samardžija, R. B. Marinenko
   Formation and composition of the $Bi_{2-x}M_xTi_2O_{7-\delta}$ pyrochlore-type phase for M=CoO, CuO and CdO
   In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 406-407.
3. Slavko Bernik, Alojz Tavčar, Zoran Samardžija, Mirjam Cergolj
   The influence of composition on the presence of the pyrochlore-type phase in ZnO-based varistor ceramics
   In: Proceedings, 39th International Conference on Microelectronics, Devices and Materials and the Workshop on Embedded Systems, October 01.-03. 2003, Ptuj, Slovenia, Giorgio Pignatel, ed., Andrej Žemva, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2003, pp. 381-386.
4. Miran Čeh, H. Gu
   Iron segregation and precipitation in Fe-doped-$SrTiO_3$
   In: Proceedings, 6th Multinational Congress on Microscopy - European Extension,

Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 452-453.

5. Miran Čeh, Sašo Šturm, Takashi Yamazaki, Kazuto Watanabe, Makoto Shiojiri
   Structure effect on intensity of atomic resolution HAADF-STEM images
   In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 165-166.
6. Nina Daneu, Roland Kröger, Angelika Vennemann, Aleksander Rečnik
   Crystallography of prism-plane inversion boudaries in Mg-doped galllium nitride
   In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 209-210.
7. Goran Dražić, Spomenka Kobe, E. Sarantopoulou, Alciviadis-Constantinos Cefalas
   Analytical electron microscopy of Tm clusters in optical grade CaF_2
   In: Proceedings, 39th International Conference on Microelectronics, Devices and Materials and the Workshop on Embedded Systems, October 01.-03. 2003, Ptuj, Slovenia, Giorgio Pignatel, ed., Andrej Žemva, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2003, pp. 393-398.
8. Medeja Gec, Miran Čeh
   Removal of surface amorphous layer from TEM samples using low energy ion-milling
   In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 483-484.
9. Oliver Gutfleisch, Goran Dražić, Chisato Mishima, Yoshinobu Honkura
   Anisotropy mechanism in HDDR processes NdFeB
   In: Bonded magnets: [proceedings of the NATO Advanced Research Workshop on Science and Technology of Bonded Magnets, Newark, USA, 22-25 August 2002](NATO sciences series, 2, Mathematics, physics and chemistry, 118), George C. Hadjipanayis, ed., Dordrecht, Boston, London, Kluwer, 2003, pp. 37-44.
10. Mouad Houabes, Slavko Bernik, Chabane Talhi, Ai Bui
    Effects of aluminum on the upturn region of the current-voltage characteristic of ZnO-based ceramics
    In: 10th International Ceramics Congress: proceedings of the 10th International Ceramics Congress, part of CIMTEC 2002 - 10th International Ceramics Congress and 3rd Forum on New Materials, Florence, Italy, July 14-18, 2002. Part D(Advances in science and technology, 33), Pietro Vincenzini, ed., Faenza, Techna, 2003, pp. 589-596.
11. Spomenka Kobe, Saša Novak, Paul J. McGuiness, Z. Yuan
    Rheological properties of coated RE-TM powders
    In: Bonded magnets: [proceedings of the NATO Advanced Research Workshop on Science and Technology of Bonded Magnets, Newark, USA, 22-25 August 2002](NATO sciences series, 2, Mathematics, physics and chemistry, 118), George C. Hadjipanayis, ed., Dordrecht, Boston, London, Kluwer, 2003, pp. 139-144.
12. Paul J. McGuiness, Spomenka Kobe
    Developing bonded HDDR magnets for a Sloveanian SME
    In: Bonded magnets: [proceedings of the NATO Advanced Research Workshop on Science and Technology of Bonded Magnets, Newark, USA, 22-25 August 2002](NATO sciences series, 2, Mathematics, physics and chemistry, 118), George C. Hadjipanayis, ed., Dordrecht, Boston, London, Kluwer, 2003, pp. 97-104.
13. Witold Mielcarek, Slavko Bernik, Krystyna Prociow, Miran Čeh
    The characteristics od ZnO-based varistor ceramics doped with $BaBiO_{2.77}$ as a precursor for Bi_2O_3
    In: Proceedings, 39th International Conference on Microelectronics, Devices and Materials and the Workshop on Embedded Systems, October 01.-03. 2003, Ptuj, Slovenia, Giorgio Pignatel, ed., Andrej Žemva, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2003, pp. 387-392.
14. Aleksander Rečnik, Masahiro Kawasaki, Takashi Yamazaki, Günter Möbus, Kazuto Watanabe, Makoto Shiojiri
    Quantitative HAADF-STEM analysis of Sb-rich inversion boundaries in zinc oxide
    In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 234-235.
15. Aleksander Rečnik, Günter Möbus, Sašo Šturm
    Quantitative HADF-STEM image analysis using IMAGE-WARP processing: presented at 31st Microscopy Conference 2003, September 7-12, Dresden, Germany
    In: Microsc. microanal. (Print), Vol. 9, suppl. 3, pp. 52-53, 2003.
16. Zoran Samardžija, Sašo Šturm, Miran Čeh
    Electron-probe microanalysis of BaO-doped $SrTiO_3$
    In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 408-409.
17. Vesna Šrot, Aleksander Rečnik, C. Scheu, Sašo Šturm, Breda Mirtič
    On the genesis of sphalerite crystals from the Trepča mines in Kosovo
    In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 199-200.
18. Sašo Šturm, Aleksander Rečnik, Miran Čeh
    Quantitative HAADF-STEM analysis of antiphase boundaries in $SrTiO_3$ doped with SrO and Cao
    In: Proceedings, 6th Multinational Congress on Microscopy - European Extension, Pula, Croatia, June 1-5, 2003, Ognjen Milat, ed., Davor Ježek, ed., Zagreb, Croatian Society for Electron Microscopy, 2003, pp. 197-198.

TECHNICAL REPORTS

1. Alojz Tavčar, Slavko Bernik, Janez Alič, Mitja Koprivšek, Mirjam Cergolj, Zoran Samardžija, Mitja Hariš
   Integrirani varistor: progress report, 2003.
2. Alojz Tavčar, Slavko Bernik, Janez Alič, Mitja Koprivšek, Mirjam Cergolj, Zoran Samardžija, Mitja Hariš
   Integrirani varistor: progress report, 2003.
3. Alojz Tavčar, Slavko Bernik, Mirjam Cergolj, Zoran Samardžija, Mitja Hariš
   Varistorji za miniaturizirane in integrirane energetske odvodnike: progress report, 2003.
4. Alojz Tavčar, Slavko Bernik, Mirjam Cergolj, Zoran Samardžija, Mitja Hariš
   Varistorji za miniaturizirane in integrirane energetske odvodnike: progress report, 2003.
5. Slavko Bernik, Alojz Tavčar, Mirjam Cergolj, Zoran Samardžija, Mitja Hariš
   High voltage ZnO-based varistor blocks: research and development activities at IJS and VARSI
   (IJS report, 8890, confidential), 2003.
6. Zoran Samardžija
   Določanje kemijske sestave, števila in deleža faz v večfaznem praškastem vzorcu EK-001-P
   (IJS report 8860, confidential), 2003.
7. Sašo Šturm
   TEM analiza TiO_2 prahov
   (IJS report, 8791), 2003.
8. Sašo Šturm, Miran Čeh
   Resistive exhaust gas sensors on the basis of temperature-independent semiconducting oxides: progress report no. 3
   (IJS report, 8864, confidential), 2003.

LECTURES - GUEST LECTURES AT FOREIGN UNIVERSITIES

1. Miran Čeh
   Atomic resolution HAADF STEM imaging: applications in ceramics with perovskite structure: invited talk
   Kyoto, Kyoto Institute of Technology, 7 May 2003.
2. Nina Daneu
   Atomic structure of basal-plane inversion boundaries in SnO2-doped ZnO: invited talk
   Bonn, Institut für Anorganische Chemie, Rheinische Friedrich-Wilhelms-Universität, 7 Nov. 2003.
3. Nina Daneu
   Inversion boundaries in zinc oxide: invited talk
   Bremen, Universität Bremen, 16 Dec. 2003.
4. Aleksander Rečnik
   Quantitative HAADF-STEM image analysis uisng IMAGE-WARP processing: invited talk
   Bonn, Institut für Anorganische Chemie, Rheinische Friedrich-Wilhelms-Universität, 7 Nov. 2003.

PATENTS

Patent application

1. No: PCT/EP03/11086
   Spomenka Kobe, Gregor Geršak, Paul John McGuiness
   Tool for measuring magnetic properties at high temperatures
   GAGEL Patentanwaltskanzlei, München, Germany, 2003

Patent granted

1. No. SI 21150 A
   Saša Novak, Srečo Maček, Goran Dražić
   A process and device for monitoring the solidification of aqueous ceramic suspensions in closed molds
   Slovenian Intellectual Property Office, Ljubljana, Slovenia, 2003

THESES

B. Sc. Thesis

1. Andreja Kralj: Septarian nodules from Gornji Štrihovec (Prof. Breda Mirtić, Dr. Aleksander Rečnik)

M. Sc. Thesis

1. Barbara Plavšić: The influence of magnetic field and impurity elements on the crystallisation form of calcium carbonate (Prof. Peter Bukovec, Prof. Spomenka Kobe)

Ph. D. Theses

1. Sašo Šturm: Antiphase boundaries and polytypic phase transformations in perovskite systems (Prof. Breda Mirtič, Dr. Miran Čeh)
2. Nina Daneu: Inversion boundaries in zinc oxide (Prof. Breda Mirtič, Dr. Slavko Bernik)

MESS SUPPORTED RESEARCH AND DEVELOPMENT GRANTS AND CONTRACTS

1. Novel permanent magnets for high temperature applications
   Dr. Matej Komelj

Research programs

1. Powder metallurgy and intermetallic magnets
   Dr. Spomenka Kobe
2. Electron microscopy and microanalysis of materials
   Dr. Miran Čeh

INTERNATIONAL PROJECTS

1. Micrometer Scale Patterning of Protein and DNA Chips
   MICROPROTEIN
   G5RD-CT-2002-00744, 5. FP
   EC; Dr. Ion Siotis, National Hellenic Research Foundation, Athens, Greece
   Dr. Spomenka Kobe
   Dr. Goran Dražič
2. Novel Permanent Magnets for High Temperature Applications
   HITEMAG
   G5RD-CT-2000-00213, 5. FP
   EC; Dr. Dimitris Niarchos, NCSR „Demokritos“, Institute of Materials Sciences, Aghia Paraskevi, Athens, Greece
   Dr. Spomenka Kobe
   Dr. Paul McGuiness
3. A Novel Miniaturised High Voltage Surge Arrester
   VARESTER
   G1ST-CT-2002-50263, 5. FP
   EC; Varsi d.o.o., Ljubljana, Slovenia
   Dr. Slavko Bernik
4. Bonded Magnets Based on RE-TM Nanocrystalline Powders
   NATO SfP - Bonded Magnets
   NATO SfP - 972428, 3311-01-837002
   NATO Scientific Affairs Division; Dr. Dimitris Niarchos, NCSR “Demokritos”, Institute of Materials Sciences, Aghia Paraskevi, Athens, Greece
   Dr. Spomenka Kobe
5. Advanced Transmission Electron Microscopy for Nanoscale Physics
   TEMNET
   Co-financing of Application for 6. FP
   Österreichisches Ost- und Südosteuropa - Institut z. H. Abt. Aussenstellen, Vienna, Austria
   Slovene Exposiure: Dr. Miroslav Polzer, Österreichisches Ost- und Südosteuropa - Institut, Ljubljana, Slovenia
   Dr. Miran Čeh
6. ZnO Based Varistors, Doped with Rare Earth Elements
   PROTEUS
   FR-2000-2
   Prof. Bui Ai, Université Paul Sabatier de Toulouse III, Laboratoire de Génie Éléctrique, Toulouse Cedex, France
   Dr. Slavko Bernik
7. Fabrication of Thin Films by Pulse Laser Deposition at 157 nm for Micro-Sensor Applications
   BI-GR/02-05-006
   Prof. A. C. Cefalas, National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, Athens, Greece
   Dr. Spomenka Kobe
8. Application of Short Wavelength Light Technologies in Treating Historical Paper Manuscripts Against Foxing
   BI-GR/02-05-004
   Dr. Evangelia Sarantopoulou, National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, Athens, Greece
   Dr. Goran Dražič
9. Characterization of Planar Faults and Boundaries on a Sub-nm Scale
   SLO-IZR-2001/04
   Prof. Wayne D. Kaplan, Technion Israel Institute of Technology, Haifa, Israel
   Dr. Aleksander Rečnik
10. Analysis of Grain Boundaries in Ceramics by HAADF Scanning Transmission Electron Microscopy and Cathodoluminiscence Microscopy
    SLO-JAP-01/03
    Prof. Hiroshi Saijo, Kyoto Institute of Technology, Kyoto, Japan
    Dr. Miran Čeh
11. Electron Microscopy Analysis of Nano-Structures in Perovskites
    SLO-JPN
    Dr. Susumu Ikeno, Faculty of Engineering, Toyama University, Venture Business Laboratory, Gofuku, Toyama-shi, Japan
    Dr. Miran Čeh
12. Atomic-Resolution HRTEM and HAADF-STEM of Mixed Oxides
    SLO-JPN
    Dr. Kenji Matsuda, Faculty of Engineering, Toyama University, Gofuku, Toyama-shi, Japan
    Dr. Sašo Šturm
13. Analytical Electron Microscopy of Interfaces in Ceramic Materials
    KIT 04-03
    Dr. Gu Hui, Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China
    Dr. Miran Čeh
14. Sub-nano Analytical Electron Mycroscopy of Interfaces and Planar Faults in Ceramic Materials
    BI-CN/03-04-017
    Dr. Gu Hui, Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China
    Dr. Miran Čeh
15. Resistive Exhaust Gas Sensors on the Basis of Temperature-Independent Semiconducting Oxides
    Electron Microscopy Investigations of $SrTiO_3$-Based Perovskites
    Dr. Wolfgang Menesklou, Universität Karlsruhe, Institut für Werkstoffe der Elektrotechnik (IWE), Karlsruhe, Germany
    Dr. Miran Čeh
16. Zinc Oxide Based Varistor Ceramics
    SVN 99/021
    Prof. Werner Mader, Universität Bonn, Institut für Anorganische Chemie, Bonn, Germany
    Dr. Aleksander Rečnik
17. Bonded Magnets Based on RE-TM Nanocrystalline Powders
    SVN 99/020
    Dr. K.-H. Müller, Dr. Oliver Gutfleisch, IFW Dresden, Institut für Festkörper und Werkstofforschung, Dresden, Germany
    Dr. Spomenka Kobe
    Dr. Paul McGuiness
18. Interfaces in Ceramics
    SVN 99/026
    Prof. Manfred Rühle, Max-Planck-Institut für Metallforschung, Stuttgart, Germany
    Dr. Miran Čeh
19. Nanostructural Properties of ZnO-based Semiconducting Materials and Thin Films
    BI-DE/03-04-008
    Prof. Werner Mader, Universität Bonn, Institut für Anorganische Chemie, Bonn, Germany
    Dr. Aleksander Rečnik
20. Electron Microscopy of Nanostructures in Ceramics
    BI-DE/03-04-012
    Prof. Manfred Rühle, Max-Planck-Institut für Metallforschung, Stuttgart, Germany
    Dr. Miran Čeh
21. Defect Structures in Semiconducting Thin-Films for Optoelectronics
    BI-DE/03-04-013
    Prof. Roland Kröger, Universität Bremen, Institut für Festkörperphysik, Bremen, Germany
    Dr. Nina Daneu
22. Cohesive Powder Fluidization Via Magnetic Excitation
    SLO-US-2001/36
    Prof. James F. Klausner, University of Florida, Gainesville, Florida, USA
    Dr. Spomenka Kobe
23. Electron Probe Microanalysis of Ceramic Materials – II
    SLO-US-2001/49
    Dr. Ryna Marinenko, National Institute of Standards and Technology (NIST), Surface and Microanalysis Science Division, Gaithersburg, MD, USA
    Dr. Slavko Bernik

NEW CONTRACTS SIGNED

1. Integrated varistor
   Varsi, Ljubljana
   Dr. Slavko Bernik

2. Varistors for miniaturised and integrated search-protection devices
   Varsi, Ljubljana
   Dr. Slavko Bernik
3. A Novel Miniaturised High Voltage Surge Arrester – VARESTER
   European Commission, Brussels, Belgium
4. The study of the influence of the magnetic field on the crystal form of the $CaCO_3$
   Termoelektrarna Toplarna, Ljubljana
   Dr. Spomenka Kobe
5. Analysis of silicated deposits and new methods of conditioning
   Termoelektrarna Toplarna, Ljubljana
   Dr. Spomenka Kobe
6. Analytical electron microscopy of materials
   Faculty for Natural Sciences, University of Ljubljana, Ljubljana
   Dr. Goran Dražič

VISITORS FROM ABROAD

1. Prof. Makoto Shiojiri and Prof. Hiroshi Saijo, Kyoto Institute of Technology, Kyoto, Japan; Prof. Kenji Matsuda, Toyama University, Faculty of Engineering, Toyama, Japan, February 25 – March 2, 2003
2. Prof. Hui Gu, Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China, March 5 – 12, 2003
3. Bo Zhu, B. Sc., Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China, March 5 – 22, 2003
4. Mirjam Cergolj, B.Sc., Alojz Tavčar, M.Sc. and Mrs. Vanja Dimec, VARSI, d.o.o. Ljubljana, Slovenia, Mario Dragoni, B.Sc., Dragoni, s.r.l., Codogno, Italy, Dr. Emilio Sacchi, PEIRS, s.r.l., Venaria, Italy, Vladimir Murko, M.Sc., Jasna Pavlič, B.Sc., and Miroslav Bajželj, B.Sc., MECOM, d.o.o., Ljubljana, Slovenia, Prof. Bui Ai, Université Paul Sabatier, Laboratoire de Génie Éléctrique, Associé au CNRS, Toulouse, France, Dr. Grzegorz Pasciak, Instytut elektrotechniki - IEL, Wrocław, Poland and Prof. Joan Muntańa, DENA, Terassa, Spain, March 6, 2003
5. Prof. Ivor Rex Harris, University of Birmingham, Department of Metallurgy and Materials, Birmingham, United Kingdom, May 9 – 11, 2003
6. Prof. Makoto Shiojiri, Kyoto Institute of Technology, Kyoto, Japan, May 28 – June 11, 2003
7. Prof. Werner Mader, Institut für Anorganische Chemie, Universität Bonn, Bonn, Germany, June 20 – 25, 2003
8. Prof. Hiroshi Saijo, Kyoto Institute of Technology, Kyoto, Japan, July 14 – 18, 2003
9. Dr. George Vekinis, Advanced Ceramic Laboratory, Institute of Materials Science, National Centre for Scientific Research – NCSR Demokritos, Athens, Greece, 10. – 13. 7. 2003
10. Ms. Daniela Hristova Milanova-Gorcheva, European Integration Department at International Cooperation and European Integration Directorate, Brussels, Belgium, Mr. Jaromír Jedlička, Úrad pro technickou normalizaci, metrologii a zkušebnictví, Prague, Checz Republic, Mr. Viktor Krutob, Eesti akrediteerimiskeskus, Talin, Estonia, Mr. Szilárd Solti, Gazdasági és Közlekedési Minisztérium, Budapest, Hungary, Ms. Inese Joppe, Ekonomikas ministrija Latvijas Republikas, Riga, Latvia, Ms. Rasa Sodeikaite, Ükio Ministerija Lietuvos Respublikos, Vilnius, Lithuania, Ms. Joanna Tkaczyk, Polskie centrum badań i certyfikacji s.a., Warszaw, Poland, Ms. Mihaela Cosmina Miu, Ministerul Economiei si Comertului, Bucarest, Romania, Mr. Martin Sencak, Úrad pre normalizáciu, metrológiu a skúšobníctvo Slovenskej republiky, Bratislava, Slovak Republic, Mr. Kay Bryder, Mr. Sřren Christian Thomsen and Ms. Marianne Jessing, Teknologisk Institut, Taastrup, Denmark, October 1, 2003
11. Elena Tchernychova, B.Sc., Max-Planck-Institut für Metallforschung, Stuttgart, Germany, October 13 – 17, 2003
12. Dr. Jae-Ho Jeon, Department of Materials Technology, Korea Institute of Machinery and Materials - KIMM, Changwon, Korea, October 14 – 17, 2003
13. Dr. George Vekinis, Advanced Ceramic Laboratory, Institute of Materials Science, National Centre for Scientific Research – NCSR Demokritos, Athens, Greece, November 6 – 10, 2003

ORGANIZATION OF CONFERENCES AND MEETINGS

1. 6th Multinational Congress on Microscopy, Pula, Croatia, June 1 – 5, 2003 (co-organization)
2. Microscopy Conference – MC 2003, Dresden, Germany, September 7 – 12, 2003 (co-organization)
3. 11th Conference on Materials and Technologies, Portorož, Slovenia, October 1 – 3, 2003 (co-organization)
4. Kick off meeting of the 5FP CRAFT project VARESTER, Ljubljana, Slovenia, March 6, 2003
5. 1st Facilitation Coordination Group of the PHARE project– Quality Infrastructure, Ljubljana, Slovenia, October 1, 2003

STAFF

Researchers

1. Dr. Slavko Bernik
2. Dr. Miran Čeh**
3. Dr. Goran Dražić
4. **Dr. Spomenka Kobe**, Head**
5. Dr. Paul John McGuiness
6. Dr. Aleksander Rečnik

Postdoctoral associates

7. Dr. Nina Daneu
8. Dr. Matej Komelj
9. Dr. Boris Saje***
10. Dr. Sašo Šturm

Postgraduates

11. Vesna Šrot, B. Sc.
12. Kristina Žužek Rožman, M. Sc.

Technical officers

13. Medeja Gec, B. Sc.
14. Zoran Samardžija, B. Sc.

Technical and administrative staff

15. Sanja Fidler, B. Sc.
16. *Anton Porenta, Eng., retired, December 31, 2003*

** Part-time faculty member
*** Member of industrial or other organisation