

# DEPARTMENT FOR NANOSTRUCTURED MATERIALS K-7

*The basic and applied research in the department 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 field of **intermetallic alloys based on RE-TM**, our main scientific contribution was the evaluation of the kinetics of the HDDR process and nitrogenation, which are the two main processes used in the preparation of Sm-Fe-N high-coercivity powders for bonded magnets. The kinetic model for the binary alloy follows the sigmoidal curve of nucleation and the kinetics of the ternary alloys depend only on the amount of unreacted material remaining. With an optimised choice of composition and processing parameters we were able to prepare powders with very high coercivity ( $H_c=1.6$  T). We have also studied the influence of the pulsed-laser deposition processing parameters on the final magnetic properties of nanoscale Sm-Fe-Ta-N films. We have developed a new method for making **thin films of Co-Pt** from a solution of electrolytes by **electrodeposition**. The coercivity that we obtained was 1 T, making the material suitable for use in micro-electro-mechanical systems. One of the highlights of last year was the development of a production process for **ultra-thin 100- $\mu$ m Nd-Fe-B magnets** with a  $H_c$  of 1.3 T using a low-temperature sintering process. In the field of hydrogen-storage materials we have designed and constructed a working hydrogen-storage measuring device, and complemented it with a high-pressure, high-temperature charging device. Experiments were performed on intermetallic alloys like  $LaNi_5$ , and the results were presented as the interdependence of the equilibrium pressure of hydrogen and the amount of hydrogen in the material ( $[H]/[M]$ ). Using a mechanical alloying process we prepared **quasicrystals based on the ternary systems Ti-Zr-Ni and Ti-Hf-Ni**. The growth of the icosahedral quasicrystalline phase was followed using X-ray diffraction, vibrating-sample magnetometry and scanning electron microscopy combined with electron diffraction spectroscopy. We have managed to index the main x-ray peaks with the corresponding six Miller indices, which confirm the existence of the **icosahedral structure**.

In the framework of the European fusion programme we continued the development of a **SiC continuous-fibre-based composite** for applications under extreme conditions. We prepared SiC-based samples with nano- and submicron-sized particles and a phosphate-based glassy phase, and analysed the effect of various process parameters on the composition, the porosity, the mechanical properties and the microstructure of the material. **Electrophoretic deposition** was studied as a potential technique for forming SiC-based materials that will enable us to prepare various thick coatings and bulk materials in future work. The microstructure of the SiC-fibre-based composite materials was studied using analytical electron microscopy. In the matrix phase, composed of SiC particles embedded in an Al-Si-P-O glassy phase, the chemical and phase compositions were monitored as a function of the processing parameters. We found that the amount of oxygen in the starting materials is a critical factor. Another investigation in the same system involved a study of the wettability of SiC fibres. Using various tenzides we improved the wettability of the originally hydrophobic SiC fibres.

Research activities on **ZnO-based ceramics** were focused on studies of the influence of very low amounts of dopant, up to several 1000 ppm, on the sintering, grain growth and microstructure development. Cations of the oxides  $Bi_2O_3$ ,  $Sb_2O_3$ ,  $Al_2O_3$  and  $MnO_2$  were added to the ZnO as aqueous solutions of their salts. The results revealed different grain-growth mechanisms that could be expected in accordance with the type of dopant and its chemistry in ZnO ceramics. This is important for the development of varistor ceramics and also for other applications of ZnO in electronics.

In collaboration with the company VARSI (Ljubljana), miniaturised varistor blocks, with their height reduced by about 25% in comparison to the standard blocks, were developed. The successful realisation of the miniaturised



Head:  
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**The department is collaborating in the European Fusion Programme and playing an active part in establishing the Slovenian Fusion Association, SFA Euratom-MHST, March 2005.**

**Our role in this long-term international programme is to collaborate in the development of advanced materials and technologies. The present research is focused on low-activation SiC/SiC materials for the first wall blanket in a future fusion reactor.**

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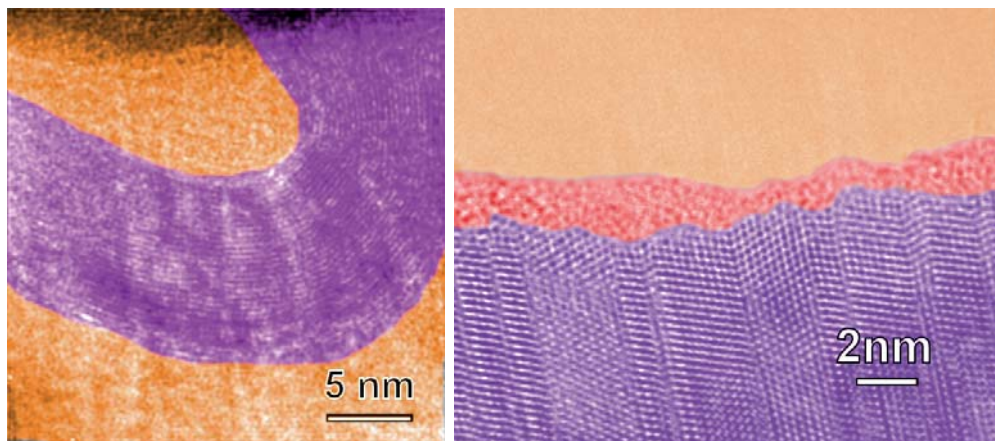


Figure 1: Nanosized crystalline feature in SiC fiber (left). Thin amorphous SiO<sub>2</sub> layer on crystalline SiC particle. (right)

varistor blocks enabled the company MECOM (Ljubljana) to develop a prototype miniaturised 24-kV arrester. In collaboration with the companies VARSI, ETI and Alfa&Omega a prototype of an integrating varistor, which combines the over-voltage protection of a varistor and the current protection of the classical fuse in one element, was developed.

During our studies of the nucleation and growth of special boundaries in ZnO doped with various additives, we investigated the **mechanisms of inversion-boundary formation**. The basic principle of inversion-boundary formation is based on the compensation of Zn<sup>2+</sup> vacancies in the ZnO structure. III<sup>+</sup> dopants (In<sup>3+</sup>) diffuse into the ZnO crystal along the basal planes, where, triggered by the charge compensation, Zn<sup>2+</sup> ions are shifted to the inverse sites of the structure. In the case of IV<sup>+</sup> (Sn<sup>4+</sup>) and V<sup>+</sup> (Sb<sup>5+</sup>) dopants, the diffusion into the ZnO structure does not occur; instead, the dopant ions are located at the octahedral sites of the structure on the surface Zn layers, causing the inversion of the structure during the subsequent growth of the crystal, which contains an inversion boundary.

We have continued our studies of **twinning in minerals** and showed that twin boundaries are chemically triggered in all the investigated crystals. In the case of contact twins in spinel crystals we have shown that the twinning is caused by the presence of beryllium, the iron-cross twins in pyrite are caused by small amounts of copper, the (301) and (101) twins of rutile are formed by an epitaxial growth of rutile domains on the ilmenite and corundum interlayers, respectively, whereas the polytipic sequences in bixbyite crystals are caused by the incorporation of silicon that forms coherent layers of braunite.

We have **developed a new method, called IMAGE-WARP**, which is used for the correction of geometrically-distorted atomically-resolved HAADF-STEM images. The method allows the extraction of up to 99% of the structural-chemical information based on Z-contrast images, compared to conventional FFT methods that restore only up to 67% of the information.

In the area of the development and implementation of atomically resolved HAADF-STEM analysis and the HAADF-STEM code for quantification, we showed, in the case of antiphase boundaries in perovskite (SrTiO<sub>3</sub>), that

the local lattice distortions across the planar faults drastically influence the intensities of atom columns at the faults and within adjacent atom planes in experimental HAADF-STEM images. This observation emphasises the necessity of a new approach to interpreting measured intensities in experimental HAADF-STEM images. The HAADF-STEM was additionally used to determine the thickness and deformation of a crystal lattice of individual GaN and GaAlN layers in a GaN/GaAlN superstructure composed of 200 consecutive GaN and GaAlN layers. In complex ferroelectric materials with a tungsten bronze-type structure we used HAADF-STEM to study the variation of the chemical composition of individual atom columns based on the measured experimental intensities. In Sr(Ti,Fe)O<sub>3</sub>-based oxygen sensors we determined the structure of the planar faults that form in the material as a consequence of Fe incorporation in the perovskite lattice. In polycrystalline PMN-PT we studied the phenomenon of exaggerated grain growth during sintering, attributing it to variations in the chemical composition of the liquid phase. In doped Al<sub>2</sub>O<sub>3</sub> ceramics we found that different Y-Al-O precipitates can be formed within Al<sub>2</sub>O<sub>3</sub> at the same time, which was not observed before. The analytical results obtained with electron-energy-loss spectroscopy showed that YAlO<sub>3</sub> (YAP) is the main secondary phase in the system, rather than Y<sub>3</sub>Al<sub>5</sub>O<sub>12</sub> (YAG). Since the amount of segregated Y at the grain boundaries depends on the type of precipitate, the variation in precipitate types in Al<sub>2</sub>O<sub>3</sub> determines the amount of segregated Y at the boundaries, which consequently influences the final mechanical properties of Y<sub>2</sub>O<sub>3</sub>-doped Al<sub>2</sub>O<sub>3</sub> ceramics.

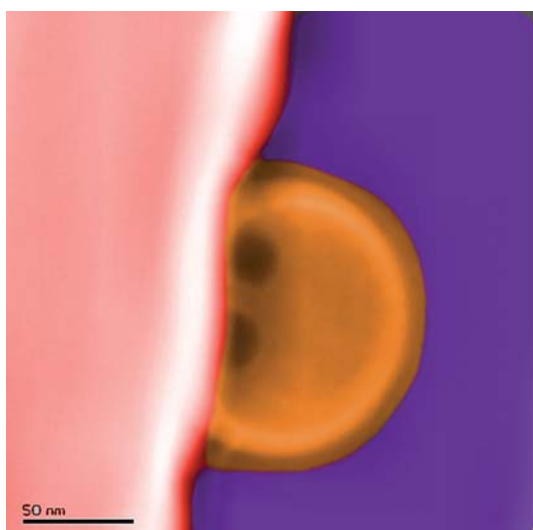


Figure 2: STEM image of Sm-Fe-Ta-N nanocrystals in a droplet deposited by pulsed laser deposition in nitrogen atmosphere.

Technologically interesting materials were also investigated using modelling. These studies focused on the field of **magnetism at the nanoscale level**, i.e., thin films and nanowires. We have also begun to model the **disproportionation kinetics** in the Sm-Fe system and study the structural properties of semiconductors, i.e., grain-boundary development in ZnO doped with Sb.

In the frame of our national project "Exploration and preservation of Slovenian mineralogical heritage" we completed several field trips to the Idrija mercury mine and collected samples from the few accessible ore bodies at the 9<sup>th</sup> and 11<sup>th</sup> levels of the mine. The samples were used to study the mineral paragenesis and the morphology of minerals that occur in tectonically shattered and richly mineralised zones of the Idrija mine.

Members of the department are, as part of the research and development program, heavily involved in managing and organising the Centre for Electron Microscopy within the frame of the national infrastructure Centre for Microstructural and Surface Analysis. The implementation of various electron microscopy analytical techniques and the access for researchers to electron microscopy research facilities is of utmost importance for numerous research institutions, industrial partners, as well as for graduate- and post-graduate education.

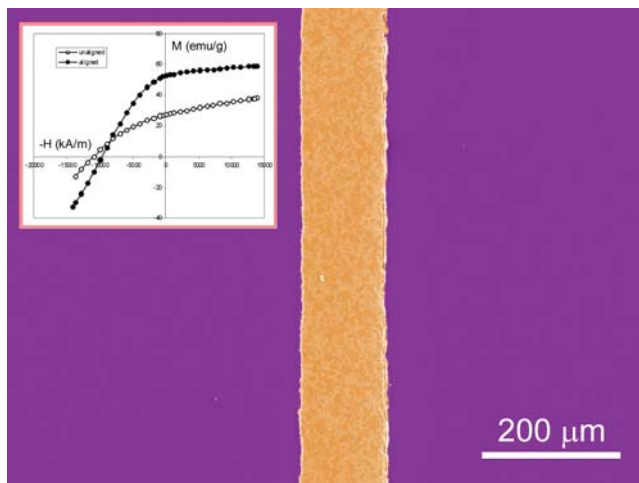


Figure 3: Nd-Fe-B thick film ( $H_c = 1.1$  T) for MAGMAS application (Magnetic Micro-Actuators & Systems).

### Some outstanding publications in the year 2005

1. A. Rečnik, G. Möbus, S. Šturm, IMAGE-WARP: A real-space restoration method for high-resolution STEM images using quantitative HRTEM analysis, *Ultramicroscopy*, 103 (2005), 285-301.
2. K. Žužek Rožman, P.J. McGuinness, M. Komelj, S. Kobe, A kinetic evaluation of the disproportionation reaction in SM-Fe-based materials, *J. magn. magn. mater.*, 290-291 (2005), 1181-1183.
3. M. Komelj, N. Stojič, *Ab-initio* investigation of magnetism in two-dimensional uranium systems, *Phys. rev., B, Condens. matter mater. phys.*, 71 (2005), 052410-1-052410-4.
4. S. Novak, G. Dražič, M. Kalin, Structural changes in  $ZrO_2$  ceramics during sliding under various environments, *Wear*, 259 (2005), 562-568.

### Patent granted

1. Paul J. McGuinness, Gregor Geršak, Spomenka Kobe  
Permeameter for measuring magnetic properties at high temperatures  
International patent, No. WO 2005/040842 A1: Geneva, The International Bureau of WIPO, 2005.

### Awards and appointments

1. Dr. Nina Daneu: Humboldt Research Fellowship, Alexander von Humboldt Foundation, Bonn, Germany, March 23, 2005
2. Dr. Sašo Šturm: "Atomic Resolution HAADF-STEM Imaging and EELS Analysis of Ruddlesden-Popper Faults in the AO-doped  $SrTiO_3$  ( $A=Sr^{2+}$ ,  $B_2=2^+$ )", Best Early Career Scientist Award, EDGE 2005, International EELS Workshop, Grundlsee, May 1 - 5, 2005
3. Jožef Stefan Institute Roll of Honour for successful scientific and technological cooperation with the Jožef Stefan Institute to VARSİ d.o.o., the long-standing partner in the development of ZnO varistors, Ljubljana, June, 2005
4. Benjamin Podmiljšak: "Ultra-Thin Sintered and Bonded Nd-Fe-B Magnets for MEMS Applications". Winning contribution of young scientists at the 13<sup>th</sup> Conference on Materials and Technologies, Portorož, October 10-12, 2005

### Organization of conferences, congresses and meetings

1. Fusion EXPO, March 21 - 31, 2005, Galery TR3, Ljubljana
2. 7<sup>th</sup> Multinational Congress on Microscopy - 7MCM, Portorož, June 26 - 30, 2005
3. 13<sup>th</sup> Conference on Materials and Technology, Portorož, October 10 - 12, 2005 (co-organisation)
4. IX Conference & Exhibition of the European Ceramic Society - ECerS 2005, Portorož, June 19 - 23, 2005 (co-organization of the Symposium Analytical Methods)

# BIBLIOGRAPHY

## ORIGINAL ARTICLES

1. Andreja Benčan, Marko Hrovat, Janez Holc, Goran Dražič, Marija Kosec: The preparation and properties of  $\text{La}_{0.5}\text{Ru}_{0.5}\text{O}_{3-x}$  and  $\text{La}_2\text{RuO}_6$ . *J. Eur. Ceram. Soc.*, Vol. 25, pp. 943-948, 2005.
2. Sabina Beranič, Saša Novak, Tomaz Kosmač, H. G. Richter, S. Hecht Mijić: The preparation and properties of functionally graded alumina/zirconia-toughened alumina (ZTA) ceramics for biomedical applications. *Key eng. mater.*, Vol. 290, pp. 348-352, 2005.
3. Matej Cimerman, Andrej Čor, Miran Čeh, Anka Kristan, Jože Pižem, Martin Tonin: Microstructural analysis of implant-bone interface of hydroxyapatite-coated and uncoated Schanz screws. *J. mater. sci., Mater. med.*, Vol. 16, pp. 627-634, 2005.
4. Tadej Dolenc, Aleksander Rečnik, Nina Daneu, Meta Dobnikar, Matej Dolenc: Celestine from the Idrija mercury-ore deposit (Western Slovenia): its occurrence and origin. *RMZ-mater. geoenviron.*, Vol. 52, no. 2, pp. 429-436, 2005.
5. Janez Dolinšek, Peter Jeglič, Paul J. McGuinness, Zvonko Jagličič, Ante Bilušić, Ž. Bihar, A. Smontara, C. V. Landauro, M. Feuerbacher, B. Grushko, K. Urban: Magnetic, electrical, thermal transport, and thermoelectric properties of the  $\xi$  and  $\Psi$  complex metallic alloy phases in the Al-Pd-Mn system. *Phys. rev., B, Condens. matter mater. phys.*, Vol. 72, pp. 064208-1-064208-11, 2005.
6. Goran Dražič, Saša Novak, Nina Daneu, Katja Mejak: Preparation and analytical electron microscopy of SiC continuous fiber ceramic composite. *J. mater. eng. perform.*, Vol. 14, pp. 424-429, 2005.
7. Yoshinobu Honkura, Chisato Mishima, N. Hamada, Goran Dražič, Oliver Gutfleisch: Texture memory effect of Nd-Fe-B during hydrogen treatment. *J. magn. magn. mater.*, Vol. 290-291, pp. 1282-1285, 2005.
8. Mourad Houabes, Slavko Bernik, Chabane Talhi, Ai Bui: The effect of aluminium oxide on the residual voltage of ZnO varistors. *Ceram. int.*, Vol. 31, pp. 783-789, 2005.
9. Mitjan Kalin, Said Jahanmir, Goran Dražič: Wear mechanisms of glass-infiltrated alumina sliding against alumina in water. *J. Am. Ceram. Soc.*, Vol. 88, pp. 346-352, 2005.
10. Yaron Kauffmann, Aleksander Rečnik, Wayne D. Kaplan: The accuracy of quantitative image matching for HRTEM applications. *Mater. charact.*, Vol. 54, pp. 194-205, 2005.
11. Spomenka Kobe, Kristina Žužek Rožman, Evangelia Sarantopoulou, Zoran Samardžija, Zoe Kollia, Alciviadis-Constantinos Cefalas: Nanocrystalline SM-Fe composites fabricated by pulse laser deposition at 157 nm. *Appl. surf. sci.*, Vol. 248, pp. 349-354, 2005.
12. Zoe Kollia, Evangelia Sarantopoulou, Alciviadis-Constantinos Cefalas, Spomenka Kobe, P. Argitis, K. Missiakos: Self assembled structures on fluoro-polymers induced with laser light at 157 nm. *Appl. surf. sci.*, Vol. 248, pp. 248-253, 2005.
13. Matej Komelj, Nataša Stojić: Ab initio investigation of magnetism in two-dimensional uranium systems. *Phys. rev., B, Condens. matter mater. phys.*, Vol. 71, pp. 052410-1-052410-4, 2005.
14. Nataša Novak Tušar, Nataša Zabukovec Logar, Gilberto Vlačić, Iztok Arčon, Denis Arčon, Nina Daneu, Venčeslav Kaučič: Local environment of manganese incorporated in mesoporous MCM-41. *Microporous and mesoporous materials*, Vol. 82, no. 1, pp. 129-136, 2005.
15. Saša Novak, Sabina Beranič: Densification of step-graded  $\text{Al}_2\text{O}_3\text{-Al}_2\text{O}_3/\text{ZrO}_2$  composites. *Mater. sci. forum*, Vol. 492-493, pp. 207-212, 2005.
16. Saša Novak, Goran Dražič, Mitjan Kalin: Structural changes in ZrO<sub>2</sub> ceramics during sliding under various environments. *Wear*, Vol. 259, pp. 562-568, 2005.
17. Urša Opara Krašovec, Marko Topič, Anneke Georg, Andreas Georg, Goran Dražič: Preparation and characterisation of nano-structured WO<sub>3</sub>-TiO<sub>2</sub> layers for photoelectrochromic devices. *J. sol-gel sci. technol.*, Vol. 36, pp. 45-52, 2005.
18. Aleksander Rečnik, Günter Möbus, Sašo Šturm: IMAGE-WARP: a real-space restoration method for high-resolution STEM images using quantitative HRTEM analysis. *Ultramicroscopy*, Vol. 103, 2005.
19. Makoto Shiojiri, Miran Čeh, Sašo Šturm, C. C. Chuo, Jung-Tsung Hsu, Jer-Ren Yang, Hiroshi Saijo: Determination of thickness and lattice distortion for the individual of strained  $\text{Al}_{0.11}\text{Ga}_{0.86}\text{N}/\text{GaN}$  superlattice by high-angle annular dark-field scanning transmission microscopy. *Appl. phys. lett.*, Vol. 87, pp. 031914-1-031914-3, 2005.
20. Angela Surca Vuk, Robi Ješe, Boris Orel, Goran Dražič: The effect of surface hydroxyl groups on the adsorption properties of nanocrystalline TiO<sub>2</sub> films. *International journal of photoenergy*, Vol. 7, no. 4, pp. 163-168, 2005.
21. Kristina Žužek Rožman, Paul J. McGuinness, Matej Komelj, Spomenka Kobe: A kinetic evaluation of the disproportionation reaction in SM-Fe-based materials: presented at the Joint European Magnetic Symposia (JEMS' 04) September 5-10, 2004, Dresden, Germany. *J. magn. magn. mater.*, Vol. 290-291, pp. 1181-1183, 2005.

## PUBLISHED CONFERENCE PAPERS

### Invited Papers

1. Miran Čeh, Sašo Šturm, Hui Gu, Makoto Shiojiri: HAADF-STEM imaging: from a qualitative to a quantitative interpretation of atomic-resolution HAADF-STEM images. 8th Inter American Congress on Electron Microscopy, CIASEM 2005: September 25-30, 2005, La Habana, Cuba: proceedings, [S.I.], CIASEM, 2005, 2 pp.
2. Miran Čeh, Sašo Šturm, Hui Gu, Makoto Shiojiri: Qualitative and quantitative interpretation of atomic resolution HAADF-STEM images. Abstract book, IX. Conference and exhibition of the European Ceramic Society, June 19-23, 2005, [Ljubljana, The Slovenian Ceramic Society], 2005, pp. 275-276.
3. Makoto Shiojiri, Miran Čeh, Hiroshi Saijo: HAADF-STEM imaging and its application to structural and compositional analysis of GaN-based violet laser diodes. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 91-94.
4. Sašo Šturm, C. Koch, Miran Čeh, Elena Tchernychova, Manfred Rühle: Quantitative HRTEM and HAADF-STEM analysis of Ruddlesden-Popper planar faults in nonstoichiometric SrTiO<sub>3</sub>. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 59-62.
5. Thomas Walther, Nina Daneu, Aleksander Rečnik: New methods for the quantitative chemical study of planar defects and interfaces by transmission electron microscopy. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 75-78.

## Regular Papers

1. Slavko Bernik: Preliminary study of ZnO-based varistor ceramics doped with Al<sub>2</sub>O<sub>3</sub>. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September 14-16, 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, 6 pp.
2. Slavko Bernik, Zoran Samardžija, Ryna B. Marinenko: Electron-probe microanalysis of ZnO grains in varistor ceramics. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 291-292.
3. L. M. Cha, Gunther Richter, Christina Scheu, T. Wagner, Sašo Šturm, Manfred Rühle: An intermetallic and metastable phase formation between Cu and Al films. Abstract book, IX. Conference and exhibition of the European Ceramic Society, June 19-23, 2005, [Ljubljana, The Slovenian Ceramic Society], 2005, pp. 347-348.
4. Miran Čeh, Sašo Šturm, Hui Gu, Makoto Shiojiri: Qualitative and quantitative interpretation of atomic resolution HAADF-STEM images. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 275-276.
5. Miran Čeh, Sašo Šturm, Makoto Shiojiri, Jung-Tsung Hsu, Jer-Ren Yang, Hiroshi Saijo: Determination of the thickness and the lattice distortions in  $\text{Al}_{0.11}\text{Ga}_{0.86}\text{N}$  and GaN layers in strained-layer superlattice cladding in GaN-based violet laser diodes. 8th Inter American Congress on Electron Microscopy, CIASEM 2005: September 25-30, 2005, La Habana, Cuba: proceedings, [S.I.], CIASEM, 2005, 2 pp.
6. Nina Daneu, Aleksander Rečnik, Tadej Dolenc: Electron microscopy study of {110} interpenetration twins of pyrite from St. Katarina NW of Ljubljana (Slovenia). Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 197-198.
7. Nina Daneu, Aleksander Rečnik, Takashi Yamazaki, Tadej Dolenc: Atomic structure of spinel twins from Mogok (Burma). Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 193-194.
8. Tadej Dolenc, Aleksander Rečnik, Nina Daneu: The origin of skeletal cinnabar crystals from the Idrija mercury mine (Western Slovenia). Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 357-358.
9. Goran Dražič, Alciviadis-Constantinos Cefalas, Spomenka Kobe, Evangelia Sarantopoulou, Zoe Kollia: Analytical electron microscopy of Tm cluster in CaF<sub>2</sub> monocrystals. 8th Inter American Congress on Electron Microscopy, CIASEM 2005: September 25-30, 2005, La Habana, Cuba: proceedings, [S.I.], CIASEM, 2005, 2 pp.
10. Goran Dražič, Saša Novak, Tea Toplišek, Katja Mejak: Electrophoretic deposition of SiC based matrix material on SiC fibres. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September 14-16, 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, pp. 101-106.
11. Medeja Gec, Miran Čeh, Makoto Shiojiri: Preparation of GaAlN/GaN layered nanostructures thin foil specimens for high resolution HAADF-STEM observation. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož,

- Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 385-386.
12. Boštjan Jančar, Sašo Šturm, Jana Bezjak, Danilo Suvorov, Peter K. Davies: Formation of twins in the  $\text{Ba}_2\text{ZnNb}_2\text{O}_9$ - $\text{Ba}_2\text{ZnWO}_6$  perovskite system. Abstract book, IX. Conference and exhibition of the European Ceramic Society, June 19-23, 2005, [Ljubljana, The Slovenian Ceramic Society], 2005, pp. 169-170.
  13. J. Jeon, Miran Čeh: Microstructural characterization of PMN-PT monocrystals grown by sintering process from polycrystalline matrix. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 287-288.
  14. Matjaž Mazaj, Nataša Zabukovec Logar, Nina Daneu, Nataša Novak Tušar, Maja Mrak, Venčeslav Kaučič: Pore distribution in a microporous/mesoporous materials BEA/MCM-41 studied by HRTEM. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 273-274.
  15. Paul J. McGuinness, David Jezeršek, Spomenka Kobe, Boris Saje: 100-[mi]m-thick sintered magnets for MEMS-type applications. Euro PM2005 Congress: October 2-5, 2005, Prague, Czech Republic, [S.l.], EPMA, 2005, pp. 427-432.
  16. Witold Mielczarek, Krystyna Prociów, Slavko Bernik: Microstructure homogenization of  $\text{ZnO-Bi}_2\text{O}_3$  ceramics using modified  $\text{Bi}_2\text{O}_3$ . MIPRO 2005: 28th international convention, May 30 - June 03, 2005, Opatija, Croatia: proceedings, Petar Biljanović, ed., Karolj Skala, ed., Rijeka, MIPRO, 2005, pp. 37-42.
  17. Elisabeth Pesch, Heike Burghardt, Werner Mader, Nina Daneu, Aleksander Rečnik: Distribution of dopant elements in pyramidal and basal-plane inversion boundaries in (Sn, Ga)-doped zinc oxide. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 285-286.
  18. Angelika Pretorius, Aleksander Rečnik, Roland Kröger: Atomic structure of basal-plane inversion boundaries of pyramidal defects in Mg-doped GaN epitaxial layers. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 311-312.
  19. Aleksander Rečnik, Nina Daneu, Slavko Bernik: Quantitative HRTEM analysis of basal-plane inversion boundaries in  $\text{SnO}_2$ -doped zinc oxide. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 271-272.
  20. Aleksander Rečnik, Nina Daneu, Hans-Joachim Kleebe, Tadej Dolenc: Electron microscopy study of {100} faults in bixbyite crystals from the Thomasrange rhyolite (Utah). Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 195-196.
  21. Zoran Samardžija, Darko Makovec: Quantitative WDXS microanalysis of  $\text{Y}_2\text{O}_3$ -doped  $\text{BaTiO}_3$ . Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 289-290.
  22. Barbara Simončič, Tea Toplišek: Influence of the surfactant structure on the surface free energy of the desized cotton fabric. Proceedings. Book 2, 5th World Textile Conference AUTEK 2005, June 27-29, 2005, Portorož, Slovenia, Alenka Majcen Le Marechal, ed., Maribor, Faculty of Mechanical Engineering, Department of Textiles, 2005, pp. 401-405.
  23. Vesna Šrot, M. Rogers, Medeja Gec: TEM sample preparation of sphalerite crystals. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 381-382.
  24. Polona Umek, Pavel Cevc, Boštjan Jančar, Adolf Jesih, Miran Čeh, Denis Arčon: Synthesis and characterisation of titania based nanotubes and nanoribbons. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražič, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 179-180.
  25. F. Wetscher, R. Pippan, Sašo Šturm, F. Kauffmann, Christina Scheu, G. Dehm: Microstructural evolution of a pearlitic steel during severe plastic deformation. Abstract book, IX. Conference and exhibition of the European Ceramic Society, June 19-23, 2005, [Ljubljana, The Slovenian Ceramic Society], 2005, pp. 187-188.
  26. Slavko Bernik, Zoran Samardžija: Vrščina elektronska mikroskopija (SEM) in mikroanaliza. Posvet o meritvah (Conference on Measurements): November 10-11, 2005, Ljubljana, Jožef Stefan Institute, 2005, 2 pp.
  27. Miran Čeh: Transmisijska elektronska mikroskopija (TEM, STEM, AEM). Posvet o meritvah (Conference on Measurements): November 10-11, 2005, Ljubljana, Jožef Stefan Institute, 2005, 2 pp.

## THESES

### B. Sc. Theses

1. Katja Mejak: The Effect of the Surface Modification of Alumina Powder on the Rheological Properties of Paraffin Suspensions for Low-pressure Injection Moulding (Prof. Andreja Zupančič-Valant, Dr. Saša Novak)
2. Matejka Podlogar: Grain Growth and Microstructure Development in  $\text{Sb}_2\text{O}_3$ -Doped  $\text{ZnO-Bi}_2\text{O}_3$  Ceramics (Prof. Tone Meden, Dr. Slavko Bernik)
6. A Novel Miniaturised High Voltage Surge Arrester  
VARESTER  
5. FP; G1ST-CT-2002-50263  
EC; Mirjam Cergolj, Varsi, d. o. o., Ljubljana, Slovenia  
Dr. Slavko Bernik
7. Micrometer Scale Patterning of Protein and DNA Chips  
MICROPROTEIN  
5. FP; G5RD-CT-2002-00744  
EC; Dr. Ion Siotis, National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, Athens, Greece  
Prof. Spomenka Kobe, Dr. Goran Dražič
8. Slovenian Fusion Association EURATOM - MHST, Public Information  
6. FP, EURATOM, SFA; FU06-CT-2004-00083, 3211-05-000017  
EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia  
Dr. Saša Novak Krmpotič
9. Energy-Filtered Transmission Electron Microscopy (EF-TEM) and High Resolution Scanning Transmission Electron Microscopy (HR-STEM) of Nanoparticles and Interfaces in Materials  
SI-AT/04-05/019  
Prof. Ferdinand Hofer, Technische Universität Graz, Institut für Elektronenmikroskopie und Feinstrukturforforschung, Graz, Austria  
Asst. Prof. Miran Čeh
10. 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
11. Analysing the Interactions of Rare-Earth Transition-Metal Alloys with Hydrogen and Nitrogen  
BI-HR/04-05-036  
Dr. Muhamed Sućeska, Brodarski Institut, Laboratorij za termičku analizu, Zagreb, Croatia  
Dr. Paul McGuinness, Prof. Spomenka Kobe
12. Precipitation of calcium carbonate in the magnetic field  
BI-HR/05-06-031

## INTERNATIONAL PROJECTS

1. Complex Metallic Alloys  
CMA  
6. FP; NMP3-CT-2005-500140  
EC; Centre National de la Recherche Scientifique, Paris, Cedex, France  
Prof. Spomenka Kobe, Prof. Janez Dolinšek, Dr. Peter Panjan
2. Novel Processing of SiC/SiC by Vacuum Slip-Infiltration of SiC Fibre Preforms - UT2  
SIC-VSI  
Slovenian Fusion Association EURATOM - MHST  
6. FP, EURATOM, SFA; FU06-CT-2004-00083, 3211-05-000017  
EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia  
Dr. Goran Dražič, Dr. Saša Novak Krmpotič
3. Gas Impermeable Coatings for SiC/SiC - UT1  
SICOAT  
Slovenian Fusion Association EURATOM - MHST  
6. FP, EURATOM, SFA; FU06-CT-2004-00083, 3211-05-000017  
EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia  
Dr. Saša Novak Krmpotič, Dr. Goran Dražič
4. Strengthening the Role of Women Scientists in Nano-Science  
WOMENINNANO  
6. FP; SAS6, 016754  
EC; Dr. Annett Gebert, IFW Dresden, Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden E.V., Dresden, Germany  
Prof. Spomenka Kobe
5. Increasing the Performance of Total Hip Replacement Prostheses Through Functionally Graded Material Innovation and Design  
BIOGRAD  
5. FP; G5RD-CT-2000-00354  
EC; Prof. Omer Van Der Biest, Katholieke Universiteit Leuven, Departement Metaalkunde en toegepaste materiaalkunde (MTM), Leuven, Belgium  
Dr. Saša Novak Krmpotič

- Dr. Damir Kralj, Institut Ruder Bošković, Zagreb, Croatia  
Asst. Prof. Spomenka Kobe
13. 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
  14. 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
  15. Electronic Ceramics with Interface Control of Electrical Properties  
BI-CN/06-07/06  
Prof. Hui Gu, Shanghai Institute of Ceramics, Shanghai, PR China  
Asst. Prof. Miran Čeh
  16. Environmental Hydrogen-based Recycling of Nd-Fe-B Magnets  
BI-CN/06-07/08  
Dr. Gaolin Yan, Harbin Institute of Technology, ShenZhen Graduate School, HIT  
Campus of ShenZhen University Town, Xili, ShenZhen, PR China  
Dr. Paul McGuinness
  17. Sub-nano Analytical Electron Microscopy of Interfaces and Planar Faults in Ceramic Materials  
BI-CN/03-04-017  
Prof. Hui Gu, Shanghai Institute of Ceramics, Shanghai, PR China  
Asst. Prof. Miran Čeh
  18. Microstructural Analysis of Perovskite-Based Electroceramic Materials  
U3-MM/K7  
Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials  
Group, Sangnam-Dong, Changwon, Korea  
Asst. Prof. Miran Čeh
  19. 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
  20. Novel Possibilities for the Processing of ZnO - Based Varistor Ceramics  
BI-PL/04-05-009  
Dr. Witold Mielcarek, Instytut elektrotechniki - IEL, Wrocław, Poland  
Dr. Bernik Slavko
  21. 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  
Dr. Dražič Goran
  22. Improved Materials Processing Through Tailoring the Surface Characteristics of Nano-  
and Micro-Sized Powders  
BI-PT-04-06-016  
Prof. Jose Maria Fereirra, University of Aveiro, Department of Ceramics and Glass  
Engineering, Aveiro, Portugal  
Dr. Saša Novak Krmpotič
  23. Development of varistor ceramics with reduced amount of dopants and improved  
microstructural and electrical characteristics  
BI-SCG/05-06-009  
Dr. Zorica Branković, Centar za multidisciplinarne studije, Univerzitet u Beogradu,  
Belgrade, Serbia and Montenegro  
Dr. Slavko Bernik
  24. Development of Single Crystalline and Electroceramic Materials by Sintering Process  
Prof. Mehmet Ali Gülgün, Sabanci Üniversitesi Mühendislik ve Doğa Bilimleri Fakültesi,  
Orhanlı Tuzla, Istanbul, Turkey  
Asst. Prof. Miran Čeh
  25. Texturing and Characterisation of ZnO-based Ceramics  
Prof. Ender Suvaci, Anadolu University, Department of Materials Science and  
Engineering, Eskisehir, Turkey  
Dr. Slavko Bernik
  26. A Hydrogen-Storage Device for Low-Cost, Environmentally Friendly Transportation  
PSP 10/2005  
Prof. IR Harris, The University of Birmingham, School of Metallurgy and Materials,  
Birmingham, Great Britain  
Asst. Prof. Spomenka Kobe, Dr. Paul McGuinness
  27. Investigations of Twinning and Epitaxial Growth in Minerals  
BI-US/04-05/5  
Dr. Hans-Joachim Kleebe, Colorado School of Mines, Metallurgical and Materials  
Engineering Dept., Golden, Colorado, USA  
Dr. Aleksander Rečnik

28. Electron Probe Microanalysis of Ceramic Materials - III  
BI-US/04-05/30  
Dr. Ryna B. Marinenko, National Institute of Standards and Technology (NIST),  
Chemical Science and Technology Laboratory, Surface and Microanalysis Science  
Division, Gaithersburg, MD, USA  
Dr. Slavko Bernik

## R & D GRANTS AND CONTRACTS

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

## RESEARCH PROGRAM

1. Nanostructured materials  
Prof. Spomenka Kobe

## NEW CONTRACTS

1. Rare-earth-transition-metal alloys for high-energy permanent magnets and metal-  
hydride batteries  
Magneti, d. d., Ljubljana  
Dr. Paul McGuinness
2. Application of new technologies to prevent scaling in industrial flow systems  
Termoelektrarna-Toplarna, Ljubljana  
Prof. Spomenka Kobe
3. Dual energy varistor for impulse currents  
Varsi, d. o. o.  
Dr. Slavko Bernik

## VISITORS FROM ABROAD

1. Igor Đerd and Mirjana Bijelić, Faculty of Science, University of Zagreb, Zagreb, Croatia, February 17–18, 2005
2. Dr. Ove T. Aanensen and Dag A. Valand, WaveTech A/S, Kristiansand, Norway, March 1, 2005
3. Dr. George Vekinis, National Centre for Scientific Research “Demokritos” – NCSR, Athens, Greece, March 24–27, 2005
4. Dr. Damir Kralj and Prof. Ljerka Brečević, Inštitut Rudjer Bošković, Zagreb, Croatia, March 24, 2005
5. Jua-juan Xing, Shanghai Institute of Ceramics, Shanghai, China, April 4–June 15, 2005
6. Dr. Witold Mielcarek and Dr. Krystyna Prociow, Elektrotechnical Institute Wrocław, Wrocław, Poland, May 29–June 1, 2005
7. Dr. Ryna Marinenko, National Institute for Standards and Technology, Gaithersburg, USA, May 30–June 2, 2005
8. Dr. Hans Joachim Kleebe, Colorado School of Mines, Denver, USA, June 12–July 3, 2005
9. Dr. Igor Đerd, Faculty of Science, University of Zagreb, Zagreb, Croatia, June 7, 2005
10. Dr. Goran Branković, Milica Počuća (June 19–July 1, 2005) and Milan Žunić (June 19–July 15 2005), Center for Multidisciplinary Studies of the Belgrade University, Serbia and Montenegro
11. Prof. Jose Maria Ferreira, Universidade de Aveiro, Aveiro, Portugal, June 18–25, 2005
12. Prof. Makoto Shiojiri, Kyoto Institute of Technology, Kyoto, Japan, June 30–July 2, 2005
13. Dr. Marek Faryna, Institute of Metallurgy and Materials Science, Polish Academy of Science, Krakow, Poland, July 3–4 2005
14. Nobuto Naranishi, Hashimoto Laboratory, Tokyo University of Science, Tokyo, Japan, July 1–4, 2005
15. Eng. Stavros Chalkiadakis, National Hellenic Research Foundation – NHRF, Athens, July 3–10, 2005
16. Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials – KIMM, Changwon-city, Kyeongnam, Korea, July 18–August 29, 2005
17. Prof. Helmut Clemens and Dr. Christina Scheu, Montan Universität Leoben, Leoben, Austria, August 3, 2005
18. Dr. George Vekinis, National Centre for Scientific Research “Demokritos” – NCSR, Athens, Greece, October 8–15, 2005
19. Dr. Marek Faryna, Institute of Metallurgy and Materials Science, Polish Academy of Science, Krakow, Poland, October 6–12, 2005
20. Prof. Constaninos Cefalas, National Hellenic Research Foundation - NHRF, Theoretical and Physical Chemistry Institute, Athens, Greece, October 8–13, 2005
21. Dr. Damir Kralj, Inštitut Rudjer Bošković, Zagreb, Croatia, October 10–12, 2005
22. Dr. Maša Rajić Linarić, Brodarski Institute, Zagreb, Croatia, October 9–12, 2005

## STAFF

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8. Dr. Aleksander Rečnik\*\*

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10. Dr. Vesna Šrot
11. Dr. Sašo Šturm
12. Dr. Kristina Žužek Rožman

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13. Andraž Kocjan, B. Sc.
14. Katja Mejak, B. Sc.
15. Tea Toplišek, B. Sc.

### Technical officers

16. Sanja Fidler, B. Sc.
17. Medeja Gec, B. Sc.
18. Benjamin Podmiljšak, B. Sc.
19. Zoran Samardžija, B. Sc.

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