

ADVANCED MATERIALS SCIENCE AND TECHNOLOGIES CENTER

Laboratories:

- Advanced Materials Synthesis
- Photoelectron Spectroscopy (XPS and UPS)
- FTIR Microscopy and Spectroscopy
- Physical Nanotechnologies (AFM, QCM based)

Research topics:

The Advanced Materials and Technologies Center is an accredited *Center of Excellence* by the National Council for University Research from 2006.

As main research topics are the following:

- local order in non-crystalline solids obtained by melts under cooling sol-gel spray drying and critical point drying, characterized by different spectroscopic methods (IR, Raman, NMR, EPR and XPS);
- structural transition from non-crystalline to polycrystalline materials by X-ray diffraction, spectroscopic and microscopic methods;
- surface characteristics of nano-structured solids and their solid-liquid interfaces function on their technological history;
- advanced materials with large specific areas for environmental applications (catalysis, sensors and molecular sieves);
- nanoassembled particles and molecules by atomic force microscopy, solid-air and solid-liquid interfaces.

Research team:

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| • Simion Simon, PhD, professor, | simons@phys.ubbcluj.ro |
| • Ioan Burda, PhD, assist. prof, | iburda@phys.ubbcluj.ro |
| • Lucian Baia, PhD, assist. prof, | lucb@phys.ubbcluj.ro |
| • Teodora Radu, PhD, researcher, | tradu@phys.ubbcluj.ro |
| • Diana Trandafir, PhD student, | dtrandafir@phys.ubbcluj.ro |
| • Oana Ponta, PhD student, | oponta@phys.ubbcluj.ro |
| • Dumitru Georgescu, PhD student, | dgeo.cnmv@gmail.com |
| • Cristina Gruian, PhD student, | cristinagruian@yahoo.com |
| • Marieta Muresan-Pop-Bardan, PhD stud., | marimarmarieta@yahoo.com |
| • Camil Mirestean, PhD student, | mc3313@yahoo.com |

Main equipments /Facilities:

- ***SPECS Multifunctional surface analysis system***

This system has a multipurpose surface analysis chamber equipped with:

- Surface analysis chamber (XPS, UPS,),
- Load lock for sample introduction,
- Analyzer PHOIBOS: with multichannel detector - ultimate energy resolution in Electron Spectroscopy experiments,
- X-ray sources: XR 50 - high power dual anode X Ray source for XPS, Focus 500 – X – Ray monochromator for high resolution XPS,
- UV source: UVS 10/35 - high UV photon flux, highest HeII/HeI ratio,
- Ion source: IQE 11/35 – extractor ion source for sample cleaning
- very clean and stable operation

The data acquisition and data processing software provides computer control of all analysis methods possible with the PHOIBOS analyzer.

Date of acquisition: 30.05.2008

- ***Atomic Force Microscope (NTEGRA Vita - NT-MDT)***

NTEGRAVita combines the strengths of SPM with an inverted optical microscope

Sealed liquid cell containing a heater enables measurements in liquid at high temperature.

The basis systems and modules:

- base unit (includes step motor and driving unit for automatic approach system, air/gas inlet/outlet, scanner (with capacitance sensors) and head connectors, bias voltage, heating stage, AFAM and second step motor connectors, temperature and humidity sensors with liquid crystal screen indicator),
- changeable measuring heads basement (scanning measuring head, STM head),
- optical viewing system (videomicroscope with manual continuous zoom and 5mm fine focus distance; inverted optical microscope OLIMPUS IX-71),
- control system (STM controller, thermocontroller, computer with the interface board),

Applications in biology, chemistry, physics and medicine.

The liquid cell is made transparent allowing for the full variety of optical measuring techniques to be used with the base unit installed in the inverted microscope: **AFM**, atomic force microscopy, **EFM**, electrostatic force microscopy, **KPM**, kelvin probe microscopy, **MFM**, magnetic force microscopy, **SCM**, scanning capacitance microscopy, **STM**, scanning tunneling microscopy

Date of acquisition: 15.01.2008

- ***FT-IR Spectrometer coupled with Microscope:***

The **JASCO system (spectrometer coupled with microscope)** is a flexible system that enables the performing of a wide range of research applications, including advanced technology applications, based on analyses of the IR data recorded from an expandable spectral range.

a) JASCO FT-IR-6000 Spectrometer:

Technical characteristics:

- high intensity ceramic light source,
- Ge coated KBr beam splitter 7800 – 350 cm^{-1} ,
- Mylar 5 μm beam splitter for measurements in the range 600 – 150 cm^{-1} ,
- Peltier thermostatted DLATGS detector,
- 28° incidence sealed Michelson interferometer driven by high-speed DSP (Digital Signal Processing) technology,
- automatic recognition and software driven auto-alignment of beam splitters, aperture selectable,
- signal to noise ratio: 45000:1 ,
- spectral resolution: 0.25 cm^{-1} ,

b) JASCO IRT-5000 Microscope:

Technical characteristics:

- automatic acquisition of IR and ATR images, spectra and maps ,
- **IQ** mapping system- enables mapping measurement without moving the stage (line mapping, multipoint measurement),
- MCT standard detector cooled with liquid nitrogen,
- transmittance and reflectance measurement modes in the 7800–650 cm^{-1} spectral range,
- 32 x Cassegrainian microscope objective,
- ATR-5000-Z objective with ZnSe prism coupled with a pressure sensor (PRS-M-5000) and other accessories against overpressure,
- automated X-Y-Z mapping sample stage with software, auto-focus and ATR mapping capabilities. Stage movement is of 100x75x25 μm in 1 μm increments, controllable by mouse, joystick or entering coordinates with a position returning accuracy of 5 μm .
- color LCD monitor (14.5 cm) for Aperture Through Optical System (ATOS) observation of sample located on the microscope.

Date of acquisition: 15.12.2008

- ***Fully Automatic Critical Point Dryer***

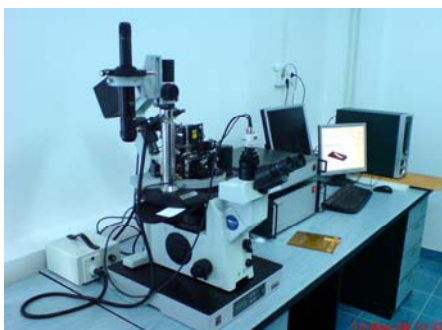
Autosamdri-815, Series A is a fully automatic critical point dryer that enables the preparation of highly porous samples with precise control of the process and very good reproducibility.

Date of acquisition: 12.01.2009

- ***Nitrogen Liquefier***

Technical characteristics: 99.5 purrity, 5 l/h

Date of acquisition: 15.12.2007



Atomic Force Microscope



XPS and UPS Spectrometer



FT-IR Spectrometer and IR Microscope



Critical point drayer



Nitrogen Liquefier

Research projects:

- “Molecular dynamics in polymeric nanocapsules. Nuclear magnetic resonance investigations”, NANODYN, CEEEX grant 58 /2006;
- “Pulse sequences adaptation and national interconnection of NMR superconducting spectroscopy laboratories”, NMRSTAR, CEEEX grant 2 cex 06-11-41 /2006;

- „Integrated technological network for powder and nanostructured film from biocompatible/bioactive glasses”, RETEBIOGLAS, CEEEX grant 307 /2006;
- “Molecular biotechnologies for ^{15}N labeling of l-aminoacids and proteins”, BIMOLAMPIN, CEEEX grant 129/2006;
- CEEEX grant 05 D11-31 /2005
- “Forme polimorfice si incapsularea substantelor bioactive in ciclodextrine pentru imbunatatirea calitatii medicamentelor”, CALIMED, CEEEX grant 7 /2005;
- “Nanocomposites with rare earth ions: structure-properties relations”, LANANOCOMP, CEEEX grant 2 cex 06-11-31 /2006;
- “Studiul clinic si experimental al unor factori privind incidenta, etiopatogenia si tratamentul neinvaziv al modificarilor de culoare dentara”, DENTCOLOR, CEEEX grant 152 /2006;
- “Static and dynamic effects of disorder, dimension and dimensionality in crystalline medium”, DISCRYS, CEEEX grant Cex 05-D11-7 /2005;
- “Procese de clusterizare in sisteme vitroase oxidice cu ioni 4f^+ ”, PROCLUST, CEEEX grant 47 /2006;
- “Nanostructured layers development on the noncrystalline silicate microspheres surface”, Idei grant 12 /2007, Cod ID566;
- “Fotocatalizatori pentru productia de hidrogen si combustibili din biomasa si ape reziduale.”, FOTOCOMB, PN-II grant 21-048 /2007;
- CEEEX grant 61-003

Partners and collaborators:

- Faculty of Physics, University of Osnabrueck, Germany;
- CEMHTI – CNRS, Orleans, France;
- Institute for Phys.-Chem., University of Jena, Germany;
- Turku Biomaterials Center, University of Turku, Finland.
- National Institute for Molecular and Isotopic Technologies, Cluj-Napoca;
- Iuliu Hatieganu University of Medicine and Pharmacy, Cluj-Napoca;
- Technical University, Cluj-Napoca;

Publications:

1. S. Simon
Structural investigation of gadolinium doped yttrium-aluminosilicate glasses and vitroceraamics
Int. J. Mod. Phys. B, 22 (12), 1933 (2008);
2. V. Simon, O. Ponta, S. Simon, D.A. Udvar, M. Neumann
Gadolinium effect on local structure of Bi₂O₃-GeO₂ glasses and vitroceraamics
Physica Status Solidi (a), 5, 1139 (2008);
3. D. Petrisor, D. Damian, S. Simon
Gamma-irradiated ExtraVit M nutritive supplement studied by electron paramagnetic resonance spectroscopy
Radiat. Phys. Chem., 77 (4), 463 (2008)
4. D. Cacaina, H. Ylanen, S. Simon, M. Hupa
The behaviour of selected yttrium containing bioactive glass microspheres in simulated body environments
Journal of Materials Science: Materials in Medicine 19 (3), 1225 (2008)
5. C. Albon, D. Muresan, R.E. Vandenberghe, S. Simon
Iron environment in calcium-soda-phosphate glasses and vitroceraamics
J. Non-Crystalline Solids, 354, 4603 (2008)
6. V. Simon, O. Ponta, S. Simon, M. Neumann
Atomic environment changes induced by rare earths addition to heavy metal glasses
J. Optoelectr. Adv. Mater., 10 (9) 2325 (2008)
7. M. Todea, S. Simon, V. Simon
Site selectivity of iron doped in silica-bismuthate heavy metal glass systems
J. Optoelectr. Adv. Mater. 10 (12) 3336 (2008)
8. M. Baia, V. Danciu, V. Cosoveanu, L. Baia,
Porous nanoarchitectures based on TiO₂ aerogels and Au particles as potential SERS sensor for monitoring of water quality,
Vib. Spectrosc. 48 (2008) 206-209.
9. L. Baia, M. Baia, V. Danciu, M. G. Albu, V. Cosoveanu, D. Iordachescu, V. Trandafir,
Type I collagen-TiO₂ aerogel based biocomposites,
J. Opto. & Adv. Mater. 10(4) (2008) 933-936.

10. S. Simon, H. Mocuța, D. Lazăr
Structure and thermal behaviour of apatitic calcium phosphates: glass melting versus sol-gel synthesis.
Studia, LIII, 1, 17-24 (2008)
11. M. Maier, V. Parvulescu, M. Tamasan, M. Vasilescu, R.F.V. Turcu, H. Mocuta, S. Simon
Structural studies on mesoporous alumina
Studia – Physica, LIII, 2, 31-38 (2008)

Abstracts:

V. Simon, O. Ponta, S. Simon, D. A. Udvar, M. Naumann
The effect of gadolinium addition on the surface structure of Bi₂O₃-GeO₂ glasses and vitroceramics
Phys. Stat. Sol. 205, nr. 5, 1139-1143, 2008

Heavy metal oxide glasses and vitroceramics belonging to the Bi₂O₃-GeO₂-Gd₂O₃ system are investigated. The changes induced by heat treatment in the elemental composition on sample surfaces are related to the local order changes. O 1s and Bi 4f core level X-ray photoelectron spectra evidence the local order changes caused by gadolinium addition to the Bi₂O₃-GeO₂ matrix and by partial crystallization of the precursor glass samples. The addition of gadolinium to the Bi₂O₃-GeO₂ glass matrix leads to a reduction of the number of bridging oxygens and a depolymerisation of the glass structure. The number of bridging oxygens increases on heat treatment of the samples.

Dina Petrisor, Gr. Damian, S. Simon
Gamma-irradiated ExtraVit M nutritive supplement studied by electron paramagnetic resonance spectroscopy
Radiation Phys. And Chem., 77, 463-466, 2008

An unirradiated and γ -irradiated nutritive supplement named ExtraVit M was studied by electron paramagnetic resonance (EPR) spectroscopy in order to detect stable paramagnetic species following improvement of hygienic quality by γ -radiation. Free radicals were induced by γ -radiation in the studied samples from low absorbed doses, showing a certain sensibility of these samples to the radiation treatment. The EPR spectrum of irradiated ExtraVit M is typical for drugs or nutritive supplements containing high level of sugars vitamin C and cellulose.

S. Simon

Structural investigation of gadolinium doped yttrium-aluminosilicate glasses and vitroceramics

International Journal of Modern Physics B, vol. 22, nr. 12, 1933-1939, 2008

Structural changes induced by heat treatment of yttrium-aluminosilicate glasses doped with gadolinium were studied by thermal differential analysis, X-ray diffraction and Gd^{3+} electron paramagnetic resonance (EPR). A small amount of yttrium was doped replaced by gadolinium in the host glass because yttrium and gadolinium cations are quite similar, and gadolinium can be used as a structural sensor by electron paramagnetic resonance measurements. EPR results evidence small changes in the surrounding of Gd^{3+} ions in the heat treated samples as compared with the as prepared ones.

C. Albon, D. Muresan, R. E. Vanderbenghe, S. Simon

Iron environment in calcium-soda-phosphate glasses and vitroceramics

J. of Non-Crystalline Solids, 354, 4603-4608, 2008

The structure of calcium-soda-phosphate glasses and vitroceramics with relatively high iron content was investigated by x-ray diffraction, electron paramagnetic resonance (EPR) and Mossbauer spectroscopy. The x-ray diffraction analysis proves the vitreous state of the as prepared samples and the development of crystalline phases in the annealed samples. The ferric ions disposed in sites that give rise to the absorption line with $g_{ef} \approx 4.3$ in the EPR spectra of vitreous samples are not more evidenced in the spectra of the annealed samples, from which only of a symmetric and narrowed line with $g_{ef} \approx 2$ is recorded. The room temperature ^{57}Fe Mossbauer spectra both of glass and vitroceramics samples consist of two quadrupole doublets characteristic for octahedral sites of Fe^{2+} and Fe^{3+} ions. The isomer shift for glass samples decreases and for vitroceramics samples increases with the iron oxide content.

V. Simon, O. Ponta, S. Simon, M. Neumann

Atomic environment changes induced by rare earths addition to heavy metal glasses

J. of Optoelectronics and Advanced Materials, vol. 10, 9, 2325-2327, 2008

The study aims to evidence the local order changes in Bi_2O_3 - GeO_2 heavy metal glasses by addition of gadolinium oxide. The elemental analysis carried out by x-ray photoemission spectroscopy shows that in the first surface layers the oxygen and germanium contents are higher than the calculated values for bulk samples while the content of gadolinium and bismuth atoms is lower than the expected values for bulk samples. Non equivalent sites of bismuth atoms are evidenced in the glasses with low Gd_2O_3 content ($x \leq 3$ mol %). The gadolinium addition to Bi_2O_3 - GeO_2 glass matrix determines the diminishing of bridging oxygens number and implicitly a depolymerisation of the glass structure. On the other hand, the decrease of full-width at half-maximum of O 1s photoelectrons peaks denotes the diminishing of the structural disorder in samples. According to the values of O 1s photoelectrons binding energy, the investigated samples are mixture of ionic and covalent oxide compounds.

M. Todea, S. Simon, V. Simon,
Site selectivity of iron doped in silica-bismuthate heavy metal glass systems,
J. of Optoelectronics and Advanced Materials, vol. 10, 12,3336-3340, 2008

Heavy metal glasses have attracted large interest due to their physical properties, such as high polarisability, long infrared cut-off or high non-linear optical susceptibility, optical transmission devices, ultrafast optical switches [1]. These properties can be influenced by doping with transition metal oxide Fe^{3+} electron paramagnetic resonance (EPR) studies on iron doped silica-bismuthates glasses and glass ceramics were carried out in order to evidence the site selectivity of iron in the local structure of samples as the ratio between Bi_2O_3 and SiO_2 content changes from 9/1 to 2/3. The environment of the resonant Fe^{3+} ions was investigated in vitreous and partially crystallized samples of similar compositions. EPR data indicate that the iron dopant occupies equivalent sites in glasses, in the entire composition range, while in vitroceramic samples the iron is differently disposed in samples as Bi_2O_3/SiO_2 ratio decreases. Structural changes induced by temperature rising in binary silico-bismuthate glasses are investigated by differential thermal analysis (DTA).

M. Baia, V. Danciu, V. Cosoveanu, L. Baia,
Porous nanoarchitectures based on TiO_2 aerogels and Au particles as potential SERS sensor for monitoring of water quality,
Vib. Spectrosc. 48 (2008) 206-209.

Encouraged by the environment friendly character of TiO_2 and the well-known affinity of a large variety of molecules to bind to the gold nanostructures surface we obtained novel porous nanoarchitectures based on TiO_2 aerogel and Au colloidal particles and tested their capability to detect contaminant species adsorbed from an aqueous solution on metallic nanoparticles surface. The efficiency of the composites prepared by various methods to detect pollutants from water by surface-enhanced Raman spectroscopy (SERS) was established by using thioacetamide, crystal violet and rhodamine 6G as test molecules and comparatively discussed. The lowest detectable concentrations were found to depend on the sample preparation method and the pollutant species type and were determined to be of around 10^{-2} M for thioacetamide and in the range between 10^{-5} and 10^{-7} M for dye molecules off and under resonant excitation, respectively. The obtained results show the real potential of the prepared porous composites for further use in the development of new SERS-based sensors for monitoring of water quality.

L. Baia, M. Baia, V. Danciu, M. G. Albu, V. Cosoveanu, D. Iordachescu,
V. Trandafir,
Type I collagen- TiO_2 aerogel based biocomposites,
J. Opto. & Adv. Mater. 10(4) (2008) 933-936.

Composites based on type I collagen and TiO_2 have been prepared by lyophilisation. Structural and morphological analyses have been performed by means of FT-Raman, FT-IR and porosimetry measurements in order to find the influence of the TiO_2 on the collagen structure. The structural information derived from the Raman spectra analysis clearly proves the existence of titania structural units inside the porous composites, but only for the highest

TiO₂ content (12 wt%). The average pores diameter and the pores density of the lyophilized samples were determined and a relationship with the titania content has been found. The fingerprint features of all FT-IR spectra are specific to the type I collagen and their close analysis revealed conformational changes of the collagen proteins caused by the TiO₂ addition, however, the integrity of the triple helicity was found to be unaltered. In vitro tests performed on fibroblast (FB) and osteoblast (OB) cells culture have revealed a very good biocompatibility of the composites, especially in the case of the 12 wt% TiO₂ containing sample.

S. Simon, H. Mocuța, D. Lazăr

Structure and thermal behaviour of apatitic calcium phosphates: glass melting versus sol-gel synthesis

Studia Physica LIII, 1, 17-24, 2008

Apatitic calcium phosphate samples were synthesized by glass melting and sol-gel methods. Hydroxyapatite crystalline phase was developed in the heat treated glass sample. A nanostructured hydroxyapatite was obtained following the sol-gel synthesis route after drying at 110°C. The structure and thermal behavior were investigated by X-ray diffraction, thermogravimetric and differential thermal analyses.

Keywords: Structure, Thermal behaviour, Sol-gel synthesis

M. Maier, V. Parvulescu, M. Tamasan, M. Vasilescu, R.F.V. Turcu, H. Mocuta, S. Simon

Structural studies on mesoporous alumina

Studia Physica - LIII, 2, 31-38, 2008

Mesoporous alumina offer the possibility of improving the catalytic efficiency of many heterogeneous catalytic processes, such as automobile exhaust control, petroleum refining and petrochemical processing. KF/Al₂O₃ catalysts with different loadings from 1 till 20 wt.% were prepared using aqueous solutions of the alkaline fluoride compounds by wetness impregnation of basic mesoporous alumina. KF supported on mesoporous alumina was characterized by Differential Thermal Analysis (DTA), Magic-Angle-Spinning Nuclear Magnetic Resonance spectroscopy (²⁷Al MAS NMR) and by X-Ray Diffraction (XRD) measurements. XRD revealed two different phases for the samples with different KF contents, identified as AlO(OH) and K₃AlF₆. MAS NMR spectra show that three types of Al species are present: hexa- and tetra-coordinated with oxygens and a hexa-coordinated one with flour.

Keywords: mesoporous alumina, catalysts, XRD, NMR, Thermal analysis.

International Conferences:

1. S. Simon, M. Todea, M. Tamasan, R.V.F. Turcu, H. Mocuta, O. Ponta
Surface properties of yttrium aluminosilicate microspheres before and after interaction with simulated body fluid
25th European Conference on Surface Science, ECOSS-25, Liverpool – UK, 27 iulie – 1 august 2008;
2. S. Simon, F. Turcu, M. Todea, M. Tamasan, D. Trandafir, O. Ponta, H. Mocuta
Surface properties of amorphous and nano-crystalline silicates microspheres
Fourth Balkan Conference on Glass Science and Technology, 27 Sept. – 1 Oct. 2008, Varna, Bulgaria;
3. R.V.F. Turcu, D. Iuga, S. Simon
Internuclear distance measurements between half-integer quadrupolar nuclei in aluminoborates
49th Experimental Nuclear Magnetic Resonance Conference, Pacific Grove, California -USA, 9-14 martie 2008;
4. F. Turcu, S. Simon, M. Vasilescu, V. Montouillout, F. Fayon, D. Massiot
Homo- and hetero-nuclear ^{31}P – ^{71}Ga NMR investigation of gallo-phosphate glass-ceramic
49th Experimental Nuclear Magnetic Resonance Conference, Pacific Grove, California -USA, 9-14 martie 2008;
5. M. Todea, S. Simon, V. Simon
Structural characteristics of silica-bismuthate heavy metal glass systems
10-th Int. Symp. On Metal Ions in Biology and Medicine, Bastia, Corsica, France, May 19-22, 2008
6. S. Simon, T. Radu, F. Turcu, M. Todea, M. Tamasan, H. Mocuta
Surface properties of amorphous and nanocrystalline oxide microspheres
8th International Conference on Physics of Advanced Materials, ICEPAM-8, June 04-07, 2008, Iasi, Romania
7. C.Gruian, L.Urban, H.Brutlach, L.V.Patmavathi, H.-J.Steinhoff, S.Simon
High-field CW-EPR study on colicine A
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
8. H. Mocuta, G. Borodi, S. Simon
Crystal structure determination of ambazone using X ray diffraction
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania

9. H. Mocuta, G. Borodi, S. Simon
Crystal structure determination of ambazone using X ray diffraction
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
10. M. Potara, D. Maniu, C. Farcau, S. Astilean
Chitosan-assisted synthesis and biofunctionalization of gold nanoparticles
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
11. T. Radu, M. Todea, S. Simon
XPS analysis of aluminosilicate microspheres functionalised in simulated body fluid
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
12. M. Todea, M. Tamasan, H. Mocuta, O. Ponta, F. Turcu, S. Simon
Structure of silica and silica-aluminium sol-gel microspheres
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
13. V. Simon, C. Popa, D. Eniu, S. Cavalu, R. Stefan, D.T. Eniu
Nanostructured composites designed for simultaneous radiotherapy and hyperthermia
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
14. Gh. Borodi, Irina Kacsó, Daniela E. Constantinescu, M. Vasilescu, S. Simon,
Solid forms of fosinopril evidenced by X-ray powder diffraction and spectroscopic methods
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
15. M. Maier, V. Parvulescu, M. Tamasan, M. Vasilescu, R.F.V. Turcu, H. Mocuta, S. Simon
Structural studies on mesoporous alumina
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania
16. O. Ponta, H. Mocuta, T. Radu, M. Vasilescu, S. Simon
Structural characterization of amorphous and polycrystalline bismuth – silicates xerogels
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania

17.D. Trandafir, O. Ponta, H. Mocuta, M. Vasilescu, S. Simon
Structure of sol-gel derived SiO₂-GeO₂ noncrystalline and nanocrystalline materials
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania

18.R.V.F. Turcu, V. Mountoulion, D. Massiot, S. Simon
³¹P – ⁷¹Ga homo-and hetero-nuclear NMR investigation of gallo-phosphate glass / glass-ceramic system
3-rd Conference on Advanced Spectroscopies on Biomedical and Nanostructured Systems, 7-10 September 2008, Cluj-Napoca, Romania