5th International Workshop on

AMORPHOUS AND NANOSTRUCTURED MAGNETIC MATERIALS

5-7 September 2011, Iaşi, ROMANIA

PROGRAMME AND ABSTRACTS

The Symposium is organized by the

National Institute of Research and Development for Technical Physics, Iași

NIRDTP Iași

Sponsored by:

National Authority for Scientific Research

&

Romanian Ministry of Education, Research and Youth

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Conference Office

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Venue

The 5th edition of the biennial workshop on Amorphous and Nanostructured Magnetic Materials will be held between 5th and 7th of September 2011 in Iasi, Romania, following the first 4 editions (2001, 2003, 2005 and 2007) held in the same location.

Known as The Cultural Capital of Romania, Iasi is a symbol in Romanian history. Still referred to as The Moldavian Capital, Iasi is the seat of Iasi County and the main economic centre of the Romanian region of Moldavia. Home to the first Romanian modern university and to the first engineering school, it is the second largest university centre in the country and accommodates over 75,000 students in 5 public and 7 private universities. The social and cultural life revolves around cultural centres and festivals, an array of museums, memorial houses, religious and historical monuments.

Iasi was the capital of the historic Principate of Moldova, was Romania's first capital (from 1859-1862), and continued to be the most important cultural centre of the country even after Bucharest became the capital of Romania in 1862.

Aims and Objectives

The workshop address to the scientific community working on amorphous and nanostructured magnetic materials (preparation, characterization, materials research and optimization for specific applications), covering the most recent developments in these fields. As a forum for novel ideas, the workshop is intended to promote contacts between fundamental research and technological needs for applications.

Scientific Programme

The scientific programme of the Workshop includes plenary and invited lectures by exceptionally well-qualified speakers to provide a through inside-view in the key fields of the amorphous and nanostructured magnetic materials, with special emphasis on nanomaterials and nanotechnology.

Researchers in the fields of materials science, physics, chemistry, biology, and engineering are welcomed to present their contributions, either as oral or poster presentations. There will be no parallel sessions.

There will be no parallel sessions. The language of the Workshop will be English.

Invited and oral presentations will be assisted by a PC-projector.

Plenary talks will be 50 minutes followed by 10 minutes of discussion, **invited talks** will be 30 minutes followed by 10 minutes discussion. **Oral presentations** will be 15 minutes talk followed by 3 minutes discussion.

Poster presentations will consist of visual materials about the work included within the accepted paper. The poster board will have the following available dimensions: max. width = 0.90 m, max. height = 1.10 m. The posters will be displayed during the entire conference and one of the authors is requested to be present during the poster session and answer the questions of the fellow participants.

Topics

A wide range of topics will be covered by the Workshop's program:

1) Materials and nanomaterials preparation and processing
2) Structural and morphological characterization
3) Magnetic properties
4) Other physical properties (electrical, optical, etc.)
5) Applications
6) Miscellaneous

The list is not closed and all the scientists working in other topics related to amorphous and nanostructured materials, are encouraged to submit their contributions to the Workshop.

ANMM'2011
-- TECHNICAL PROGRAMME --

MONDAY September 5, 2011	
9:00 – 9:30	**OPENING SESSION**
Plenary Session 1 / Chair: Horia CHIRIAC	
9:30 – 10:30	**PL.1** **IEEE Magnetics Society 2011 Distinguished Lecturer** **M. FUTAMOTO** *Chuo University, Tokyo, JAPAN* GROWTH-CONTROL AND MICROSTRUCTURE CHARACTERIZATION OF MAGNETIC THIN FILMS, APPLICATION TO HIGH DENSITY PERPENDICULAR MAGNETIC RECORDING MEDIA
10:30 – 11:00	**COFFEE BREAK**
Plenary Session 2 / Chair: Masaaki FUTAMOTO	
11:00 – 11:40	**I.1** **J. SORT[1], A. VAREA[2], L.F. BONAVINA[3], C. SOUZA[3], W.J. BOTTA[3], C. BOLFARINI[3], C.S. KIMINAMI[3], S. SURIÑACH[2], M.D. BARÓ[2], J. NOGUÉS[4]** *[1]Institució Catalana de Recerca i Estudis Avançats and Departament de Física, Universitat Autònoma de Barcelona, Bellaterra, SPAIN* *[2]Departament de Física, Universitat Autònoma de Barcelona, Bellaterra, SPAIN* *[3]Departamento de Engenharia de Materiais, Universidade Federal de Sao Carlos, Sao Carlos, BRAZIL* *[4]Institució Catalana de Recerca i Estudis Avançats (ICREA) and Centre d'Investigació en Nanociència i Nanotecnologia (ICN-CSIC), Campus UAB, Bellaterra, SPAIN* MAGNETIC LITHOGRAPHY BASED ON INDENTATION-INDUCED NANOCRYSTALLIZATION OF METALLIC GLASSES
11:40 – 12:20	**I.2** **A. MAKINO** *Institute for Materials Research, Tohoku University, Sendai, JAPAN* NEW HIGH Bs-FeSiBPCu NANOCRYSTALLINE SOFT MAGNETIC ALLOYS CONTRIBUTABLE TO ENERGY-SAVING
12:20 – 13:00	**I.3** **I. ŠKORVÁNEK[1], J. MARCIN[1], J. KOVÁČ[1], B. IDZIKOWSKI[2], P. ŠVEC[3]** *[1]Institute of Experimental Physics, Slovak Academy of Sciences, Kosice, SLOVAKIA* *[2]Institute of Molecular Physics PAS, Poznań, POLAND* *[3]Institute of Physics, Slovak Academy of Sciences, Bratislava, SLOVAKIA* AMORPHOUS AND NANOCRYSTALLINE FeCo- AND GdFeCo-BASED ALLOYS WITH IMPROVED APPLICATION-ORIENTED PROPERTIES
13:00 – 13:40	**I.4** **O. ISNARD[1], I. CHICINAŞ[2], B. NEAMŢU[2], O. Geoffroy[3], V. POP[4], F. POPA[2]** *[1]Institut Néel, CNRS, Université Joseph Fourier, Grenoble, FRANCE* *[2]Materials Sciences and Technology Department, Technical University of Cluj-Napoca, Cluj-Napoca, ROMANIA* *[3]G2ELab, Université Joseph Fourier, CNRS , Grenoble, FRANCE* *[4]Faculty of Physics, Babeş-Bolyai University, Cluj-Napoca, ROMANIA* OBTAINING OF Ni-Fe BASED NANOCRYSTALLINE SOFT MAGNETIC MATERIALS BY MECHANICAL MILLING: A STRUCTURAL AND MAGNETIC STUDY

13:40 – 15:00	**LUNCH**
Plenary Session 3 / Chair: Nora DEMPSEY	
15:00 – 15:40	**I.5** **M. VÁZQUEZ and L.G. VIVAS** *Institute of Materials Science of Madrid, CSIC, Madrid, SPAIN* Co-BASE NANOWIRE ARRAYS: THE ROLE OF MAGNETOCRYSTALLINE ANISOTROPY
15:40 – 16:20	**I.6** **A. ROTARU[1,2], J. LIM[1,3], D. LENORMAND[1,4], A. SRIVASTAVA[1,4], J. VARGAS[1], J.B. WILEY[1,3], A. STANCU[5], and L. SPINU[2,4]** *[1]Advanced Materials Research Institute, University of New Orleans, New Orleans, LA 7014, USA* *[2]Faculty of Electrical Engineering and Computer Science, Suceava University, Suceava, ROMANIA* *[3]Department of Chemistry, University of New Orleans, New Orleans, LA 7014, USA* *[4]Department of Physics, University of New Orleans, New Orleans, LA 7014, USA* *[5]Faculty of Physics, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* STATIC AND DYNAMIC PROPERTIES OF COMPLEX MAGNETIC NANOWIRE ARRAYS WITH TUNED STRENGTH OF INTERACTIONS
16:20 – 16:50	**COFFEE BREAK**
16:50 – 17:30	**I.7** **D. SUSAN-RESIGA[1,2], V. SOCOLIUC[1], O. MARINICĂ[3], L. VÉKÁS[1,3]** *[1]Romanian Academy-Timisoara Branch, CFATR, Lab. MF, Timişoara, ROMANIA* *[2]West University Timisoara, Faculty of Physics, Timişoara, ROMANIA* *[3]Politehnica University Timisoara, NCESCF, Timişoara, ROMANIA* HIGH MAGNETIZATION FERROFLUIDS: COMPOSITION, COLLOIDAL STABILITY AND FLOW BEHAVIOR
17:30 – 18:10	**I.8** **S. BAGLIO** *Microsystems Group & NanoTechLab, Dipartimento di Ingegneria Elettrica Elettronica e Informatica, University of Catania, ITALY* EXPLOITING MAGNETIC MATERIAL PROPERTIES AND NONLINEAR BEHAVIOURS FOR SENSING APPLICATIONS: MAGNETIC MICROWIRES AND MAGNETORHEOLOGIC FLUIDS
18:10 – 18:50	**I.9** **P. FREITAS** *(INESC MN, Lisbon, PORTUGAL)* TBA
19:00 – 20:30	**POSTER SESSION & SNACKS & BIERSTUBE**

TUESDAY September 6, 2011	
Plenary Session 4 / Chair: Alexandru STANCU	
9:00 – 10:00	**PL.2** **J. LYUBINA** *Department of Materials, Imperial College London, London, UNITED KINGDOM* ADVANCED MATERIALS FOR ENERGY EFFICIENT MAGNETIC COOLING
10:00 – 10:40	**I.10** **M. MARINESCU, B. CUI and J.F. LIU** *Electron Energy Corporation, Landisville, PA 17538, USA* PERMANENT MAGNET NANOFLAKES
10:40 – 11:20	**I.11** **N.M. DEMPSEY[1], F. DUMAS-BOUCHIAT[1], Y. ZHANG[1], G. CIUTA[1], L.F. ZANINI[1,2] AND D. GIVORD[1]** *[1]Institut Néel CNRS / Université Joseph Fourier, Grenoble, FRANCE* *[2]G2Elab, INP de Grenoble, St. Martin d'hères, FRANCE* HIGH PERFORMANCE HARD MAGNETIC FILMS: FROM MODEL SYSTEMS TO MICRO-SYSTEM APPLICATIONS
11:20 – 11:50	**COFFEE BREAK**
11:50 – 12:30	**I.12** **N. NISHIYAMA[1], K. TAKENAKA[1], N. SAIDOH[1] and A. INOUE[2]** *[1]RIMCOF Tohoku University Laboratory, The Materials Process Technology Center, Sendai, JAPAN* *[2]Institute for Materials Research, Tohoku University, Sendai, JAPAN* NANO-PATTERING OF GLASSY ALLOY THIN FILMS FOR THE APPLICATION OF BIT-PATTERNED-MEDIA
12:30 – 12:50	**O.1** **B. NEGULESCU[1], D. LACOUR[2], M. HEHN[2], A. GERKEN[3], J. PAUL[3] and C. DURET[4]** *[1]LEMA, Université François Rabelais, Tours, FRANCE* *[2]IJL, Université Nancy, Vandoeuvre-les-Nancy, FRANCE* *[3]Sensitec GmbH, Mainz, GERMANY* *[4]NTN-SNR Annecy, FRANCE* THE SPIN FLOP EFFECT IN SYNTHETIC ANTIFERROMAGNETS: APPLICATION TO THE ORTHOGONAL PINNING OF MAGNETIC FIELD SENSORS
12:50 – 13:30	**I.13** **M. CHARILAOU[1,2], K.K. SAHU[2], A.U. GEHRING[1], J.F. LÖFFLER[2]** *[1]ETH Zurich, Department of Earth Sciences, Earth and Planetary Magnetism, Zurich, SWITZERLAND* *[2]ETH Zurich, Department of Materials, Laboratory of Metal Physics and Technology, Zurich, SWITZERLAND* THERMODYNAMIC MAGNETIC PROPERTIES OF MIXED-SPIN Fe–Ti OXIDES
13:30 – 15:00	**LUNCH**
Plenary Session 5 / Chair: Julia LYUBINA	
15:00 – 15:40	**I.14** **Y. OTANI[1,2], S. SUGIMOTO[1], Y. FUKUMA[2], and S. KASAI[3]** *[1]Institute for Solid State Physics, University of Tokyo, Kashiwa, Chiba, JAPAN* *[2]Advanced Science Institute, RIKEN, Saitama, JAPAN*

	[3]National Institute for Materials Science, Tsukuba, JAPAN COUPLED VORTEX DYNAMICS IN PERMALLOY SUBMICRON DISK PAIRS
15:40 – 16:20	**I.15** **G. GAUDIN[1], I.M. MIRON[1,2], T. MOORE[1,3], H. SZAMBOLICS[1], K. GARELLO[2], P.J. ZERMATTEN[1], M.V. COSTACHE[2], S. AUFFRET[1], S. BANDIERA[1], B. RODMACQ[1], L.D. BUDA-PREJBEANU[1], A. SCHUHL[1], S. PIZZINI[3], J. VOGEL[3], M. BONFIM[4], P. GAMBARDELLA[2,5]** *[1]SPINTEC, UMR-8191, CEA/CNRS/UJF/GINP, INAC, Grenoble, FRANCE* *[2]Centre d'Investigació en Nanociència i Nanotecnologia (ICN-CSIC), UAB Campus, Barcelona, SPAIN* *[3]Institut Néel, CNRS/UJF, Grenoble, FRANCE* *[4]Departamento de Engenharia Elétrica, Universidade Federal do Paraná, Curitiba, Paraná, BRAZIL* *[5]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, SPAIN* RASHBA SPIN-ORBIT TORQUES IN FERROMAGNETIC THIN FILMS
16:20 – 17:00	**I.16** **D. PETIT, E.R. LEWIS, L. O'BRIEN, A.-V. JAUSOVEC, H.T. ZENG, J. SAMPAIO, A. FERNANDEZ-PACHECO, D. READ and R.P. COWBURN** *Department of Physics, Cavendish Laboratory, University of Cambridge, Cambridge, UNITED KINGDOM* DYNAMIC BEHAVIOUR OF DOMAIN WALLS IN FERROMAGNETIC NANOSTRIPS
17:00 – 17:20	**O.2** **M. ŢIBU, M. LOSTUN, T.A ÓVÁRI, and H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* INVESTIGATION OF DOMAIN WALL PROPAGATION IN SUB-MICRON GLASS COVERED WIRES BY MAGNETO-OPTICAL KERR EFFECT
17:20 – 17:50	**COFFEE BREAK**
17:50 – 18:30	**I.17** **E. KANIUSAS[1], H. PFÜTZNER[1], S. TRAXLER[1], M. VAZQUEZ[2] and G. VARONECKAS[3]** *[1]Institute of Electrodynamics, Microwave and Circuit Engineering, Vienna University of Technology, Vienna, AUSTRIA* *[2]Instituto de Ciencia de Materiales de Madrid, Spanish National Research Council, Madrid, SPAIN* *[3]Mechatronics Science Institute, Klaipeda University, Klaipeda, LITHUANIA* TECHNICAL AND MEDICAL APPLICATIONS OF MAGNETOSTRICTIVE BILAYER SENSORS
18:30 – 19:10	**I.18** **J. KOSEL** *King Abdullah University of Science and Technology, Thuwal, SAUDI ARABIA* DEVELOPMENT OF MAGNETOSTRICTIVE MICROSENSORS FOR MICROFLUIDIC SYSTEMS
20:00 – 22:30	**CONFERENCE DINNER**

WEDNESDAY September 7, 2011	
Plenary Session 6 / Chair: Jordi SORT	
9:00 – 10:00	**PL.3** **R. COWBURN** *Department of Physics, Cavendish Laboratory, University of Cambridge, Cambridge UNITED KINGDOM* DOMAIN WALLS IN MAGNETIC NANOWIRES
10:00 – 10:40	**I.19** **L. KRAUS** *Institute of Physics, ASCR, Prague, CZECH REPUBLIC* FERROMAGNETIC RESONANCE IN MICRON AND SUBMICRON AMORPHOUS WIRES
10:40 – 11:20	**I.20** **A. STANCU** *"Alexandru Ioan Cuza" University of Iaşi, Faculty of Physics, Department of Physics and CARPATH, Iaşi, ROMANIA* MAGNETIC CHARACTERIZATION OF MATERIALS USING FORC TECHNIQUE: QUALITIES AND LIMITS
11:20 – 11:50	**COFFEE BREAK**
11:50 – 12:30	**I.21** **V. IN, P. LONGHINI, A. KHO, D. LEUNG, J.D. NEFF, AND B.K. MEADOWS** *SPAWAR Systems Center Pacific, Code 71730, San Diego, CA 92152, USA* NONLINEAR CHANNELIZER FOR RF COMMUNICATION
12:30 – 13:10	**I.22** **C.-M. TEODORESCU** *National Institute of Materials Physics, Bucharest-Magurele, ROMANIA* INTERPLAY BETWEEN REACTIVITY AND MAGNETISM AT METAL/SEMICONDUCTOR INTERFACES
13:10 – 14:30	**LUNCH**
Plenary Session 7 / Chair: Manuel VÁZQUEZ	
14:30 – 15:10	**I.23** **V. POP[1], O. ISNARD[2] and I. CHICINAS[3]** *[1]Faculty of Physics, Babeş-Bolyai University, Cluj-Napoca, ROMANIA* *[2]Institut Néel, CNRS, Joseph Fourier University, Grenoble, FRANCE* *[3]Materials Sciences and Technology Department, Technical University of Cluj-Napoca, Cluj-Napoca, ROMANIA* STRUCTURAL AND MAGNETIC BEHAVIOUR OF HARD/SOFT NANOCOMPOSITE MAGNETIC MATERIALS OBTAINED BY MECHANICAL MILLING
15:10 – 15:30	**O.3** **C.E. CIOMAGA[1], M. AIRIMIOAEI[2], V. NICA[1], L.M. HRIB[1], O.F. CĂLŢUN[1], A.R. IORDAN[2], C. GALASSI[3], L. MITOŞERIU[1] and M.N. PALAMARU[2]** *[1]Faculty of Physics, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* *[2]Faculty of Chemistry, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* *[3]ISTEC-CNR, Faenza, ITALY* PREPARATION AND MAGNETOELECTRIC PROPERTIES OF $NiFe_2O_4$-PZT CERAMIC COMPOSITES
15:30 – 15:50	**O.4** **L.P. CURECHERIU[1], I.V. CIUCHI[1], G. APACHITEI[1], A. NEAGU[1], M.T.**

	BUSCAGLIA[2], V. BUSCAGLIA[2], P. POSTOLACHE[1], L. MITOSERIU[1] *[1]Department of Physics, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* *[2]Institute for Energetics & Interphases - CNR, Genoa, ITALY* MAGNETIC AND DIELECTRIC PROPERTIES OF $Ba_{12}Fe_{28}Ti_{15}O_{84}$ NATURALLY SELF-ASSEMBLED LAYERED CERAMICS
15:50 – 16:10	**O.5** **H. CHIRIAC, D.-D. HEREA, N. LUPU, M. LOSTUN** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* HEATING EFFICIENCY EVALUATION OF LOW-Tc GLASSY Fe-Cr-Nb-B MAGNETIC MICROPARTICLES FOR MAGNETIC HYPERTHERMIA
16:10 – 16:30	**CLOSING REMARKS**
16:30 – 17:00	**COFFEE BREAK**
17:00 – 19:00	**LABTOUR**
20:00 – 22:00	**DINNER**

POSTER SESSION	
P.1	**R. SABOL[1], R. VARGA[2], J. BLAZEK[1], J. HUDAK[1], D. PRASLICKA[1], P. VOJTANIK[2], G. BADINI[3], M. VAZQUEZ[3]** *[1]Faculty of Aeuronautics, TU Kosice, Košice, SLOVAKIA* *[2]Institute of Physics, Faculty of Sciences, UPJŠ, Košice, SLOVAKIA* *[3]Instituto de Ciencia de Materiales de Madrid, CSIC, Madrid, SPAIN* STRESS DEPENDENCE OF THE SWITCHING FIELD IN GLASS-COATED MICROWIRES
P.2	**T.-A. ÓVÁRI, S. CORODEANU and H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* MAGNETOELASTIC AND MAGNETOSTATIC ANISOTROPY IN RAPIDLY SOLIDIFIED AMORPHOUS NANOWIRES
P.3	**H. CHIRIAC, S. CORODEANU, G. ABABEI, G. STOIAN and T.-A. ÓVÁRI** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* GIANT MAGNETO-IMPEDANCE EFFECT IN RAPIDLY SOLIDIFIED NANOWIRES
P.4	**I. ASTEFANOAEI, I. DUMITRU, A. STANCU** *Department of Physics, Faculty of Physics, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* THE TEMPERATURE FIELD IN THE PULSED LASER HEATED MAGNETIC NANOWIRES
P.5	**M. LOSTUN, H. CHIRIAC, N. LUPU, and T.-A. ÓVÁRI** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* MAGNETOSTATIC INTERACTIONS IN ARRAYS OF ELECTRODEPOSITED NANOWIRES INVESTIGATED BY MAGNETO-OPTICAL KERR EFFECT
P.6	**A. ATITOAIE, R. TANASA, C. ENACHESCU, A. STANCU** *Faculty of Physics and CARPATH Center, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* SIZE EFFECTS IN THERMAL TRANSITION OF SPIN CROSSOVER NANOPARTICLES STUDIED BY AN ISING-LIKE MODEL
P.7	**A. LUNGU and A. STANCU** *Faculty of Physics, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* LLG STUDY FOR THE TRANSVERSE SUSCEPTIBILITY DETERMINATION IN THE FERROMAGNETICS PARTICLES SYSTEM
P.8	**I. BODALE, C. DOBROTĂ and A. STANCU** *"Alexandru Ioan Cuza" University, Department of Physics, Iaşi, ROMANIA* IDENTIFICATION TECHNIQUE FOR PREISACH-TYPE MODELS APPLIED TO STRONGLY INTERACTING SYSTEMS
P.9	**C. ROTĂRESCU, A. STANCU** *"Alexandru Ioan Cuza" University, Faculty of Physics, Department of Solid State and Theoretical Physics, Iaşi, ROMANIA* A STUDY OF THE FLUCTUATION FIELD USING AN ISING-PREISACH MODEL
P.10	**C. PINZARU, L. STOLERIU, O. RUSU and A. STANCU** *Departament of Physics, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* MICROMAGNETIC INVESTIGATION OF SWITCHING BEHAVIOR OF SYNTHETIC ANTIFERROMAGNETIC DOTS
P.11	**C. DOBROTĂ, A. STANCU** *"Alexandru Ioan Cuza" University, Faculty of Physics and CARPATH Center, Iaşi, ROMANIA* NONPARAMETRIC IDENTIFICATION PROCEDURE FOR PREISACH MODEL FOR PATTERNED MEDIA (PM2)
P.12	**I. URSACHI[1], P. POSTOLACHE[1], A. VASILE[2], H. CHIRIAC[3] and A. STANCU[1]** *[1]Department of Physics and CARPATH Center, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* *[2]Department of Chemistry, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA*

	[3]National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA Fe_3O_4 CORE - MCM-41 SHELL NANOPARTICLES: SYNTHESIS AND CHARACTERIZATION
P.13	**D.-D. HEREA, N. LUPU, H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* SYNTHESIS, FUNCTIONALIZATION AND CHARACTERIZATION OF OCTAHEDRAL IRON OXIDE NANOPARTICLES VIA A HYDROTHERMAL ROUTE
P.14	**M. GABURICI, H. CHIRIAC, N. LUPU** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* SYNTHESIS OF MAGNETITE NANOPARTICLES UNDER A MICROWAVE FIELD USING ORGANIC FERROUS SALTS
P.15	**M. GABURICI, H. CHIRIAC, N. LUPU** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* SOLID-PHASE EXTRACTION OF SOME AZO-DYES FROM ENVIRONMENTAL WATER SAMPLES USING ANIONIC MAGNETIC CLAYS
P.16	**G. STOIAN, A.C. RASCANU and H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* DAMPERS BASED ON MAGNETORHEOLOGICAL FLUIDS FOR VIBRATION CONTROL
P.17	**G. STOIAN, N. LUPU and H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* DESIGN OF NANOSTRUCTURES AND NANOCONTACTS FOR SENSING APPLICATIONS USING FOCUSED ION BEAM
P.18	**H. CHIRIAC, S. CORODEANU, G. ABABEI, G. STOIAN, and T.-A. ÓVÁRI** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* HIGH FREQUENCY MAGNETIC PROPERTIES OF NANO-PATTERNED MEANDER STRUCTURES
P.19	**G. ABABEI, T-A ÓVÁRI and H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* SELECTIVE MICROWAVE ABSORPTION PROPERTIES OF CoFe-BASED GLASS-COATED AMORPHOUS MICROWIRES
P.20	**F. BORZA, S. CORODEANU, N. LUPU and H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* FeCuNbSiB/CoPt(Cu) MAGNETIC MICROWIRES
P.21	**I.L. VELICU[1], M. NEAGU[1], N. LUPU[2], H. CHIRIAC[2], V. TIRON[1] and M. DOBROMIR[1]** *[1]Physics Department, "Alexandru Ioan Cuza" University, Iaşi, ROMANIA* *[2]National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* FeCuNbSiB THIN FILMS DEPOSITED BY HIPIMS: ANNEALING INFLUENCE ON THE STRUCTURAL AND MAGNETIC PROPERTIES
P.22	**M. GRIGORAS, N. LUPU, and H. CHIRIAC** *National Institute of Research and Development for Technical Physics, Iaşi, ROMANIA* COMPOSITION CONTROL AND MAGNETIC PROPERTIES OF CoFeSiB THIN FILMS PREPARED BY CO-SPUTTERING METHOD
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GROWTH-CONTROL AND MICROSTRUCTURE CHARACTERIZATION OF MAGNETIC THIN FILMS, APPLICATION TO HIGH DENSITY PERPENDICULAR MAGNETIC RECORDING MEDIA

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Various magnetic thin films are used for recording media and heads of hard disk drives. The magnetic properties have been greatly improved to cope with a continuous areal density increase of more than 10^4 times over the past quarter century. The improvement has been realized by tailoring the composition and the microstructure of magnetic thin films.

This lecture covers the technology and the physics for controlling the microstructure of magnetic thin films, focusing mainly on perpendicular recording media and related magnetic materials. Initially, technological developments will be briefly reviewed and then the following topics will be discussed: (1) nucleation and growth of magnetic thin films through heteroepitaxy on nonmagnetic underlayers, (2) nanostructure and nano-composition characterization, (3) application to perpendicular magnetic recording media, (4) magnetization structure analysis, (5) epitaxial growth of single-crystal magnetic thin films with stable, metastable and ordered crystal structures, and (6) patterned-type perpendicular recording media for higher densities. The relationships between film microstructure and magnetic properties will also be discussed.

ADVANCED MATERIALS FOR ENERGY EFFICIENT MAGNETIC COOLING

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Near room temperature magnetic cooling, based on the magnetocaloric effect (MCE), is an emerging technology that has the potential to reach higher efficiency than the conventional vapour compression/expansion approach. Successful operation of a magnetic cooling device depends crucially on the performance of an active magnetic refrigerant material. The first condition posed on the magnetic refrigerants – a large (giant) MCE – guides us to the use of materials experiencing a first-order magnetic phase transition. However, large hysteresis and poor mechanical stability arising as a consequence of the first order transition have a detrimental effect on the material performance. Extensive research activity has been concentrated on optimising the magnetic properties of these materials by chemical composition modification, while little effort has been made in terms of microstructure design to overcome these problems. Here, it is shown how the design of appropriate microstructure can be used to control the magnetic properties and mechanical stability of refrigerant materials with the first order transition. In particular, introducing porosity in $LaFe_{13-x}Si_x$ alloys provides long-term stability by sacrificing only a small fraction of the MCE value and results in the desired reduction of the magnetic and thermal hysteresis. Reducing crystallite size from the micro- to nanometer range leads to both strong hysteresis and MCE reduction. The magnetic and thermal properties of composite materials will be discussed.

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DOMAIN WALLS IN MAGNETIC NANOWIRES

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Nanometre scale planar magnetic nanowires can exhibit a special magnetic property known as domain wall (DW) conduit behaviour in which DWs can be transmitted along the nanowire by the application of weak magnetic fields or electrical currents. This opens up the possibility of integrated circuits containing complex networks of nanowires in which information is carried, stored and processed by DWs flowing along nanowire conduits. In this talk I describe the main features of how artificial structures such as constrictions, side arms and crossed wires modify the energy landscape of a moving DW and explain the key role that the chirality of the transverse component of the DW plays in understanding how DWs interact with artificial structures. I show how DWs interacting with each other can be measured experimentally using a 'near-pass' pair of conduits [1], how the DW chirality can be probed through a 'chirality filter' formed from a crossing nanowire [2], what happens to DWs as they move around a curved conduit [3] and how a high efficiency DW-gate (the DW equivalent of a transistor) can be formed from a T-stub nanowire [4]. As an example of technological applications, I demonstrate a working non-volatile 32-bit memory block with four electrically integrated inputs based on nanwire shift registers [5]. Finally, I show a new variant on this nanomagnetic system in which a magnetisation structure related to the domain wall can be injected into vertically layered magnetic heterostructures leading to the possibility of ultrahigh density 3-dimensional spintronic devices.

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MAGNETIC LITHOGRAPHY BASED ON INDENTATION-INDUCED NANOCRYSTALLIZATION OF METALLIC GLASSES

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A novel lithography method based on nanoindentation of Fe-based glassy ribbons, initially displaying in-plane magnetic anisotropy, is used to fabricate periodic arrays of ferromagnetic dots with perpendicular-to-plane magnetic easy axis. The indentation stresses cause local nanocrystallization of the $Fe_{67.7}B_{20}Cr_{12}Nb_{0.3}$ (at %) glassy structure [1]. The local changes in the microstructure have been observed by transmission electron microscopy whereas the magnetic properties have been evaluated using a magneto-optic Kerr effect setup and magnetic force microscopy. Our results indicate that the indented regions in the Fe-based metallic glass exhibit enhanced coercivity and Curie temperature and larger saturation magnetization than the surrounding non-deformed matrix. Moreover, only the indented zones show perpendicular anisotropy, whereas the non-deformed surrounding matrix maintains its original longitudinal magnetic anisotropy. Detrimental effects caused by the dipolar/exchange interactions between the dots and the matrix can be avoided by heating the indented ribbon above T_C of the glass (340 K), since the crystallized regions (consisting of α-Fe) remain ferromagnetic up to very high temperatures ($Tc_{,\alpha\text{-}Fe}$ = 1050 K). Hence, heating to only slightly above room temperature renders a microstructure consisting of non-interacting ferromagnetic dots with out-of-plane magnetization surrounded by a paramagnetic matrix. The preferential orientation of the crystallized region (i.e., crystallographic texture), together with the inverse magnetostriction or Villari effect, are the main factors that contribute to the change in the magnetic anisotropy direction. Our results are of particular technological relevance for the fabrication of miniaturized magnetic devices.

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NEW HIGH *Bs*-FeSiBPCu NANOCRYSTALLINE SOFT MAGNETIC ALLOYS CONTRIBUTABLE TO ENERGY-SAVING

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Continued growth in electrical power generation and the recent energy problem strongly require decreasing wasteful dissipation of energy. Electrical power loss resulting from the magnetic core losses (***W)*** cannot be ignored. For example, electrical power loss resulting from ***W*** is estimated to be 3-4% in total electric power consumption, which is corresponding to about 3% of total CO_2 emission in Japan. Silicon steel discovered more than 100 years ago is still now the most major soft magnetic material for the power applications due to the highest magnetic flux density (***B***) of about 1.7-2T among soft magnetic materials and a lower material cost, besides the improvement of magnetic loss of silicon steel seems to reaches the limitation. Reduction of tremendous amount of ***W*** in many kinds of motors, transformers and so far requires development of new soft magnetic materials with low ***W*** combined with high ***B***.

$Fe_{83.3\text{-}86}Si_{1\text{-}4}B_{8\text{-}10}P_{2\text{-}4}Cu_{0.7\text{-}1}$ nanocrystalline soft magnetic alloys [1-3] prepared by crystallizing an unusual as-quenched nanohetero-amorphous phase including a large amount of extremely small bcc Fe (less than 2-3nm in size)grains exhibit high ***B*** of above 1.8-1.9T (at 800 A/m)almost comparable to the commercial oriented silicon steel, along with extremely low ***W*** which is 1/2-1/3 smaller than that of the highest-grade oriented silicon steel and about one-order smaller than those of non-oriented silicon steels at maximum flux density of 1.7T [3]. The new FeSiBPCu nanocrystalline materials with lower materials cost due to absence of rare-metals are expected to not only contribute to reduction of CO_2 emission through significant reduction in ***W*** but also be useful to conserve the Earth's resources and environment.

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AMORPHOUS AND NANOCRYSTALLINE FeCo- AND GdFeCo-BASED ALLOYS WITH IMPROVED APPLICATION-ORIENTED PROPERTIES

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FeCo - based amorphous and nanocrystalline alloys combine a high saturation magnetic flux density with good magnetic softness. In order to further optimize the magnetic performance of these alloys it is important to deepen knowledge about the influence of the processing techniques that can be used to tailor their properties for specific applications. One possible way, which can be employed for this purpose, is the thermal processing under the presence of external magnetic field, called also „magnetic annealing“. A special attention of our work is devoted to the study of the effects of the magnetic annealing in order to produce a controllable uniaxial anisotropy in the series of Fe-Co-(Nb,Mo)-B and Fe-Co-B-Cu amorphous and nanocrystalline alloys. We show that the specimens annealed without the presence of external magnetic field show an appreciable increase of the coercivity and the corresponding hysteresis loops often exhibit a presence of steps due to the depinnig of domain walls from the positions stabilized during annealing. After annealing in transverse magnetic field one can obtain sheared loops with tunable slope and good field linearity. A heat treatment under the presence of longitudinal magnetic field results in squared hysteresis loops characterized by low coercivity values. Examples of our recent work on the FeCo-based soft magnetic amorphous and nanocrystalline alloys optimized for sensor applications will be briefly highlighted.

Among the recently developed magnetic refrigerant materials, the Gd(Fe,Mn)Al-based glassy alloys prepared by melt–spinning combine favourable magnetic entropy characteristics with sufficiently high effective magnetic moment per volume, which makes them good candidates for magnetic refrigeration in intermediate range between cryogenic and room temperature. In this talk, we report on a beneficial effect of partial Co substitution for Fe on the magnetocaloric behaviour in the melt-spun Gd-Fe-Co-Al-(Si,B) ribbons. The highest values of the maximal magnetic entropy change, ΔS_M, and the refrigeration capacity, RC, for the $Gd_{65}Fe_{10}Co_{10}Al_{10}B_5$ ribbon under 50 kOe reached 7.02 J/kg K and 766 J/kg, respectively. The markedly enhanced values ΔS_M as compared to the Co-free compositions extended over a wide temperature range together with the good magnetic softness leading to the low hysteresis losses make these amorphous ribbons promising magnetic refrigerants in the temperature range from 80 to 220 K.

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OBTAINING OF Ni-Fe BASED NANOCRYSTALLINE SOFT MAGNETIC MATERIALS BY MECHANICAL MILLING: A STRUCTURAL AND MAGNETIC STUDY

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Nowadays the seek for nanocrystalline soft magnetic materials exhibiting enhanced magnetic properties is an active field of research in the scientific and engineering community involving both fundamental investigations in magnetism as well as applied ones. The Ni-Fe based alloys are among the most used soft magnetic materials. Here we focus on the production of such alloys by means of high energy mechanical milling aiming to produce nanoscale crystallites and optimized magnetic properties. The synthesis conditions have been investigation for both the dry and wet milling conditions. The effect of post-milling heat treatment on the alloy formation is also presented.

The structural properties have been investigated at each steps of the milling process enabling to determine the effect of the different milling conditions on the production of these alloys. In particular, we have been followed the evolution of the crystal lattice and of the crystallite size. Powders magnetic properties (magnetization, coercive field, Curie temperature) have also been determined on the produced powders shading a different light on the alloy formation and phase purity. Finally, we have developed a protocol (method + parameters) of wet/dry mechanical alloying followed by an annealing at low temperature for producing of nanocrystalline soft magnetic powders.

Co-BASE NANOWIRE ARRAYS: THE ROLE OF MAGNETOCRYSTALLINE ANISOTROPY

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The magnetization process of magnetic nanowires and their ordered arrays is determined by the combined action of different anisotropy energy contributions as shape, crystalline structure and magnetostriction, as well as by the magnetostatic interactions among nanowires. The magnetostatic interaction contribution has been thoroughly studied, and it is particularly important, in those nanowires with reduced magnetocrystalline and magnetoelastic energy terms (e.g., Permalloy nanowires) [1]. Less attention has been paid to the important influence of magnetocrystalline energy contribution which is particularly relevant in Co and Co-base nanowires [2].

In this work we will review our recent achievements regarding the magnetization reversal process of arrays of Co-base nanowires and its correlation to the crystalline structure. Arrays of Co and Co-base (e.g., CoNi and CoPd) nanowires were fabricated by template-assisted method, by electroplating into highly ordered self-assembled pores of nanoporous alumina membranes. The hcp or fcc crystal structure of nanowires is confirmed to depend on the length of nanowires as well as on the presence of selected elements in the composition. The magnetic behaviour of these arrays has been experimentally investigated as a function of (i) geometry (e.g. diameter and, particularly short length; for Co) and (ii) composition (e.g., adding Ni or Pd). A complementary study on the temperature dependence of main hysteresis parameters (e.g. coercivity and remanence) reveals the nature of the dominant anisotropy, and allows us a deeper analysis of the magnetization reversal process. Micromagnetic reversal simulated mechanisms are reviewed, and particularly complex rotational mechanisms are concluded to be responsible for the reversal process.

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STATIC AND DYNAMIC PROPERTIES OF COMPLEX MAGNETIC NANOWIRE ARRAYS WITH TUNED STRENGTH OF INTERACTIONS

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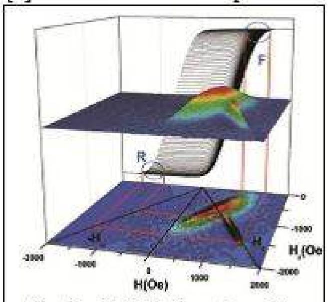
Magnetic nanowires are an important class of magnetic nanostructured materials. One of the most important effects in magnetic nanowire arrays is the interwire magnetostatic interactions. In order to be able to understand the obtained experimental results reliable methods for interactions evaluation are needed. To quantify the effect of interactions one needs on the one hand a suitable method to experimentally vary the strength of interactions in arrays of magnetic nanowires and on the other hand a method to measure the effect of the interactions. In this study, we present a comprehensive investigation of magnetic interactions in arrays of magnetic nanowires grown in highly-ordered anodic alumina membranes.
The static magnetic properties were probed using vibrating sample magnetometry following several measurements protocols. Interactions and static magnetization reversal of Ni nanowires arrays have been investigated by the first order reversal curves (FORC) method [1]. Several series of samples with controlled spatial distribution were considered including including simple wires of different lengths and diameters (70 nm and 110 nm) and complex wires with single modulated diameter along their length [2]. Subtle features of magnetic interactions are revealed through a quantitative analysis of the local interaction field profile distributions obtained from FORC. In addition the FORC analysis indicates that the nanowire systems with a mean diameter of 70 nm appear to be organized in symmetric clusters indicative of a reversal-field memory effect [3]. The dynamics in the magnetic nanowire arrays was investigated by ferromagnetic resonance (FMR). FMR experiments were carried out at room and low temperature using a X-band FMR spectrometer. The FMR spectra at room temperature and at 4.2 K show a main line associated with a uniform mode. The angular variation of this line is characteristic of an easy axis along the wire length for the three samples. . At low temperature the dynamic response was different from that at room temperature depending on the strength of interactions in each sample.



A family of FORCs from the a 4.8 µm long nanowire array (vertical-back panel), the corresponding FORC 3D distribution (top horizontal panel) and FORC diagram (bottom horizontal panel).

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HIGH MAGNETIZATION FERROFLUIDS: COMPOSITION, COLLOIDAL STABILITY AND FLOW BEHAVIOR

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High magnetization ferro fluids require high volume fraction of magnetic nanoparticles and at the same time, improved colloidal stability. These requirements are difficult to fulfill simultaneously and implies severe conditions on the MNP synthesis/stabilization/ dispersion procedures applied during the preparation of magnetic nanofluids. In this paper the particle surface coating and volume fraction, as well as the size distribution and magnetic moment density of dispersed particles will be considered in correlation with colloidal stability, magnetic and flow properties of magnetizable fluids. Based on previous small angle neutron scattering results concerning the efficiency of various chain length (C12-C18) carboxylic acids in sterical stabilization of magnetite nanoparticles in a non-polar organic carrier [1], we present a study on the colloidal stability of a series of mineral oil based magnetic nanofluids with particle solid (physical) volume fraction up to 20 % by means of rheological, magnetization and transmission electron microscopy investigations, as well as by magnetogranulometry analysis. The dependence of the dynamic viscosity on solid volume fraction it was found to fit well especially with the Krieger-Dougherty formula investigated beside other dependencies, such as the formulas of Quemada, Chong and Chow. From the fit to Krieger-Dougherty formula the thickness of the effective surfactant (oleic acid) layer was estimated at 1.4 nm, in very good agreement with the value found from previous SANS investigations. A major change of flow behavior and magnetic properties is achieved by dispersing micron sized Fe particles in a high concentration magnetite nanofluid, with saturation magnetization in the range of 80-100 kA/m [2]. The resulting extremely bidisperse magnetizable fluid samples show strongly non-Newtonian flow properties and up to 10^3 times increase of effective viscosity. The magnetization curves M=M(H) of the nano-micro structured magnetizable fluid samples show a Fröhlich-Kennelly type dependence and their saturation magnetization attains 900 kA/m. A comparison is presented with similar properties of conventional MR fluids.

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EXPLOITING MAGNETIC MATERIAL PROPERTIES AND NONLINEAR BEHAVIOURS FOR SENSING APPLICATIONS: MAGNETIC MICROWIRES AND MAGNETO-RHEOLOGIC FLUIDS

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This talk will focus on a general methodology which allows to exploit nonlinear hysteretic behaviours, as in the case of ferromagnetic or ferroelectric materials, toward sensing devices and transducers. Among other examples, particular emphasis will be given to the case of fluxgate magnetometers with amorphous microwire and transducer devices based on ferrofluids.

PERMANENT MAGNET NANOFLAKES

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The potential applications of permanent magnet powders with submicron particle size range from nanocomposite magnets, with a maximum energy product predicted to be twice as high as the current state of the art magnets, to MEMS components. However, the fabrication of ultra-fine rare earth – transition metal (-metalloid) powders has proved in the last decade to be very challenging.

This talk reviews our most recent results on the synthesis of permanent magnet nanoflakes based on rare earth – transition metal RE-TM(-M) compounds, produced by surfactant assisted high energy ball milling.

High-energy ball milling, which for a long time has been used to produce nanocrystalline and amorphous materials, has been employed for the synthesis of submicron particles with high aspect ratio (1: 10^3) and flake geometry. The thickness of the flakes decreases with milling time and, when optimum magnetic properties are achieved, can vary in the 10- 50 nm range. The role of surfactant is twofold: to keep the particles / nanoflakes separated and assist an anisotropic breakage during the milling process. The studied alloys were based on $Sm(Pr)Co_5$ and $(Nd,Dy)_2Fe_{14}B$ intermetallic compounds. The $Sm(Pr)Co_5$ nanoflakes exhibit an out of plane crystallographic and magnetic texture, whereas $(Nd,Dy)_2Fe_{14}B$ nanoflakes exhibit an in plane texture. Intrinsic coercivity H_{ci}, of up to 18kOe were obtained for $Sm(Pr)Co_5$ and 4 kOe for $(Nd,Dy)_2Fe_{14}B$ as-synthesized nanoflakes. In general, $(BH)_{max}$ did not exceed 22 MGOe. Figure 1 shows typical $Sm(Pr)Co_5$ nanoflakes forming stacks due to magnetostatic interactions. The talk will elaborate in detail on the texture development and associated magnetic properties of the nanoflakes.

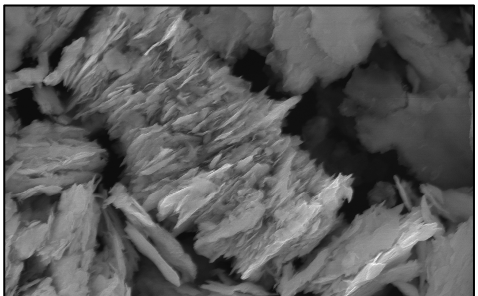

Fig. 1. $Sm(Pr)Co_5$ nanoflakes synthesized by surfactant assisted high energy ball milling.

HIGH PERFORMANCE HARD MAGNETIC FILMS: FROM MODEL SYSTEMS TO MICRO-SYSTEM APPLICATIONS

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RE-TM based permanent magnets are used in applications which require magnets with very high energy densities. A domain of application of major and growing importance concerns high performance motors, such as the motors used in hybrid electric vehicles or those used in gearless wind turbines. Much effort is now going into reducing and ultimately eliminating the need for Dy in the bulk NdFeB based magnets presently used in these applications. At the same time, micro-systems incorporating high performance RE-TM micro-magnets have many potential applications in the fields of bio-medicine, information technology, energy transformation/management. The development of such systems has been hindered to-date by the challenges faced in integrating these materials at the appropriate scale using techniques compatible with today's MEMS technologies [1].

In this presentation we will report on the preparation of NdFeB and SmCo films in thick film form on Si substrates [2,3]; the analysis of magnetization reversal in NdFeB films; the role played by stress in developing coercivity in such films [4]; the lateral patterning at the micron scale of both NdFeB and SmCo films using both topographic and thermo-magnetic methods [5,6]; the characterization of the stray magnetic fields produced by these patterned films using local, non-destructive methods [7]. Finally, some examples of devices presently being developed using hard magnetic films will be briefly presented, e.g. [8].

Acknowledgement

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NANO-PATTERING OF GLASSY ALLOY THIN FILMS FOR THE APPLICATION OF BIT-PATTERNED-MEDIA

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As according to remarkable progress in information technologies, data storage devices are strongly required to have much higher data density.Bit-patterned media (BPM)[1] having isolated and perpendicular magnetic recording dots are expected to be a next generation data storage system for hard-disk-drive due to their resistivity against thermal demagnetization [2]. Owing to dense and random atomic configuration as well as viscous deformability, it is well known that glassy alloys (GAs) are preferable materials for nano-replication by thermal imprinting in their supercooled liquid region.Recently, we have succeeded in feasibility confirmation of novel production process for BPM using nano-patterned GA thin film [3,4].
Pd-Cu-Ni-P glassy alloy thin film with a thickness of about 20 nm was deposited onto water-cooled Si disk substrate using a magnetron sputtering method. Detailed condition for deposition was already reported elsewhere [5]. Using an EB lithographed mold with a dot diameter of 30 nm and a pitch of 60 nm, nano-hole-array was formed on the surface of Pd-based GA thin film. Prototype BPM were completed by deposition of Co/Pd multilayer onto nano-patterned GA thin film. Expected cross sectional construction was confirmed by TEM observation. In addition, surface roughness of less than 4 nm for the prototype BPM was revealed by AFM measurements, suggesting that the superior surface flatness is enough for information reading/writing (R/W) head flying. Furthermore, information R/W properties examined by static tester under contacting condition using a commercial R/W head will be presented.

Acknowledgement

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THERMODYNAMIC MAGNETIC PROPERTIES OF MIXED-SPIN Fe – Ti OXIDES

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In this work, experimental and theoretical investigations of the mixed-spin oxide (x)$FeTiO_3$ – (1-x)Fe_2O_3 are presented. This solid solution orders as a ferrimagnet, or antiferromagnet, depending on the composition x. For compositions $0.7 < x < 0.9$, the system exhibits pronounced frustration due to the competition between Fe(II) and Fe(III) spins. The frustration is manifested in a spin-glass-like freezing process at low temperature. Deep in the frozen state ($T < 3.0$ K), the system exhibits transition-like magnetization jumps during hysteresis loop measurements which are attributed to a layer-wise partitioning of the magnetic structure. Moreover, zero-field-cooled and field-cooled measurements of the magnetic moment over a wide temperature range reveal that the thermodynamic behavior of the system can be changed depending on the bias-field during cooling. This can be explained by the change in layer configuration from antiparallel to a meta-stable parallel due to the external field. The experimental observations are interpreted using a four-layer mean-field model and reveal that the layer configuration can be controlled. Finally, these findings show how the magnetic properties of such a mixed-spin oxide can be controlled by means of cation doping and external fields, towards controllable thermodynamics.

COUPLED VORTEX DYNAMICS IN PERMALLOY SUBMICRON DISK PAIRS

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A magnetic vortex is an ideal constituent element for magnetically coupled systems that exhibit intriguing collective dynamics. The vortex is a stable flux-closure structure in a disk shaped ferromagnet and produces no stray field. However the gyration mode is an excited circular vortex motion in the self-induced parabolic potential, and causes the emerging magnetic fields from the side edge that result in magnetostatic coupling between nearby vortices. Here, we demonstrate experimentally that coupled gyration modes can be resonantly excited by the ac current in a pair of ferromagnetic disks. Resistance measurements reveal that the paired vortices behave as a pseudo-diatomic molecule of which resonance modes correspond to bonding and anti-bonding states as predicted in the previous theoretical work [1].

Figure (a) shows the measurement circuit together with an scanning electron microscope (SEM) image of the sample, where both disks have the same dimension, 1 μm in diameter and 50 nm in thickness. Figure (b) shows the resonance spectra of samples for an isolated single Py disk and two neighbored Py disks with the edge-to-edge separation of 75 nm and different combinations of polarities $p_1p_2 = \pm 1$. The detected voltage V_{dc} is divided by the magnitude of applied ac current I_{ac} and the spectra are plotted in the unit of Ohm. For comparison, dc spectrum for single disk is shown as green symbols in Fig. (b), where a sole dip in V_{dc}/ I_{ac} is observed at 352 MHz corresponding to the resonance frequency of the vortex core precession. When the *ac* current is applied to the one of the two neighboring Py disks, the mode splitting takes place as can be seen in black and red spectra in Figure (b). This is due to a magnetostatic coupling caused by side-surface magnetic charges associated with collective spin dynamics of resonance modes. The polarity p_1 of the excited vortex can be switched by extremely high $I_{ac.}$ of about 20 mA (about 3.5×10^{11} A/m^2 for our systems) at the resonance frequency similarly to the previous work [2]. For anti-parallel polarities p_1p_2 = -1, the magnitude of splitting is slightly enhanced by several MHz. Similar mode splitting is also observed for the separation x of 75 nm and 150 nm, whereas the splitting vanishes and turn to the sole dip for $x > 250$ nm.

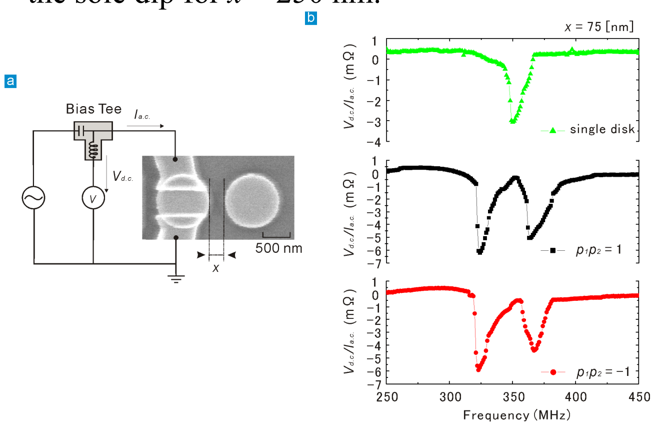

Fig. (a) Schematic diagram of the measurement circuit and a scanning electon micrograph. Two Copper electrodes are attached to the one of the paired Permalloy disks. (b) Frequency dependence of the normalized dc voltage V_{dc}/I_{ac} measured for an isolated disk (green triangles) and for the parired disks with different polarities (black squares for p_1p_2 = 1, and red circles for p_1p_2 = -1). Measurements are carried out with the a.c. current amplitude I_{ac} = 3.8 mA for the single disk, and I_{ac} = 6.3 mA for the paired disks with the edge to edge distance x = 75 nm, respectively.

All the observed behaviors can be explained by using Thiele's equation including the

anisotropic magnetostatic interaction energy.
The unique property in this system gives us a guiding principle for designing the magnonic crystal in further expanded systems such as one-dimensional chains and two dimensional arrays and is a candidate for novel tunable oscillators using vortices.

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RASHBA SPIN-ORBIT TORQUES IN FERROMAGNETIC THIN FILMS

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We investigate novel spin torque mechanisms based on spin-orbit effects in structurally asymmetric ferromagnetic metal layers. It is well known that spin-orbit coupling is ultimately responsible for magnetocrystalline anisotropy and damping. Under certain conditions, however, spin-orbit effects might either induce or enhance specific spin torque mechanisms. We analyze these effects by using two tri-layer structures (Pt/Co/Pt and Pt/Co/AlOx) with similar magnetic properties but opposite structural inversion parity.

One of the effects of the spin-orbit interaction is to induce deviations from pure conservation of angular momentum as an electric current is injected in a domain wall (DW). Therefore, besides the adiabatic spin-torque component, a second non-adiabatic component will appear [1]. Due to its equivalence to an easy axis magnetic field, this second component is expected to be very efficient for inducing DW motion. We observe a 50-fold increase of the nonadiabatic component related to the breaking of the structural inversion symmetry [2] (Rashba interaction). This enhancement is confirmed by the subsequent observation of DW displacements under ultra-short current pulses. We measure ultrafast DW motion with velocities approaching 400 m/s. Despite the strong pinning characterizing these samples, the DW displacements show high reproducibility demonstrating the potential for applications [3]. Besides these effects occurring in DWs, the Rashba interaction is also predicted to create a torque in the uniformly magnetized domains [4]. Unlike spin-transfer-torque, this second phenomena does not rely on injection of spin polarized current from another magnetic layer or adjacent domain. By the intermediate of the Rashba interaction, the conduction electron spin couples to the crystalline electric fields, and as a current is applied, a spin accumulation transverse to both the current direction and electric field is created. Further on, due to the s-d exchange interaction coupling the conduction electron's spins to the localized magnetic moments, the spin accumulation will act as an effective magnetic field on the magnetization. Using a wide field Kerr microscope, we study the effect of current on uniform magnetization. We demonstrate that strong magnetic fields can be induced in ferromagnetic metal films presenting structure inversion asymmetry (SIA) [5].

Finally, we demonstrate switching of a perpendicularly magnetized cobalt dot sandwiched in a SIA, driven by in-plane current injection at room temperature [6].

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DYNAMIC BEHAVIOUR OF DOMAIN WALLS IN FERROMAGNETIC NANOSTRIPS

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Controlling domain wall (DW) motion in thin soft ferromagnetic nanowires is the subject of intense research at the moment, due to their potential use in technological applications such as DW based shift registers for high density data storage [1, 2]. For these devices, it is vital to control the position as well as the morphology and speed of the DWs.It is now well established that static DW pinning by local geometrical changes in the DW conduit as well as by localised stray fields depends on the chirality of the DWs (chirality filtering effect) [3].The Walker breakdown (WB) phenomenon [4], whereby a DW moving under the influence of a magnetic field above the critical WB field continuously changes its chiralitywhile goinginto phases of retrograde motion, has dramatic effects on the pinning properties of a given trap and on the DW speed.

In this talk I will give an overview of our recent findings on the dynamical pinning of DWs above the WB field. I will show how the presence of a chirality-dependent trap can not onlyreset the chirality of a DW as it is undergoing WB, but also restore the monotonic increase of the DW speed with driving magnetic field [5]. I will also show how the pinning of a given trap is affected by the dynamical state of the incoming DW, particularly in the WB regimewhere a range of kinetic depining fields are observed [6], as opposed to a single kinetic depining field for a DW travelling below WB.

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TECHNICAL AND MEDICAL APPLICATIONS OF MAGNETOSTRICTIVE BILAYER SENSORS

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A new type of magnetostrictive bilayer sensors was developed within an international consortium formerly based on the EU project B-SENS [1]. Manufacturing technology has been established and novel applications introduced. In brief, the bilayer sensors exhibit sensitivity for bending and/or temperature [2] through specific arrangements of layers. Basically, a magnetoelastic layer (ML) is affixed to a non-magnetic counter layer (CL) forming a bilayer; bending or heating of the latter induces nearly uniform mechanic stresses in ML. The resulting permeability changes within ML are transformed to an output signal reflecting bilayer curvature or temperature.

The technological approaches considered not only different materials for ML and CL but also different geometries of the bilayers and various combination methods to form the bilayer. The manufactured sensors range from miniature thick bilayers wires over micro-bilayers with rectangular structures up to centimetre sized macro-bilayers.

In the technical field, curvature, displacement, acceleration, temperature, and flow sensors were realised. Air flow sensors were realised with non-contact signal establishment, especially, with the focus on automotive sector [3].

In the medical field, the bilayer sensors were applied for the registration of cardiac activity, respiratory activity, eye movements, muscle activity, fetal movements, leg movements, sleep apneas, body position, blood pressure, and cranial circumference variations. For the first time, physiological data hidden in the regional skin deformations was assessed and evaluated. A true multiparametric recording of diverse physiological signals was realized.

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DEVELOPMENT OF MAGNETOSTRICTIVE MICROSENSORS FOR MICROFLUIDIC SYSTEMS

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Amorphous and nanocrystalline materials have been applied as resonancebased sensors for various applications. The principle of detection is the change in resonant frequency upon a mass loads or stress on the sensor's surface, whereby the sensitivity is proportional to the resonant frequency. Magnetostrictive materials enable to vibrate the sensors in longitudinal mode. The resonant frequency of this mode is typically an order of magnitude larger than the one in transversal mode. While magnetostrictive macro sensors have shown great performance, their potential in the micro domain has yet not been fully utilized.

We will show a material process to fabricate magnetostrictive iron-nickelmolybdenum (FeNiMo) thin films by co-sputtering of iron-nickel (FeNi) and molybdenum. The results indicate that the concentration of Mo significantly changes the microstructure and magnetic properties of the material. Further, we are going to introduce fabrication processes to obtain magnetostrictive micro sensors in form of cantilevers as well as untethered particles for the application in integrated microfluidic systems for chemical and biological detection.

FERROMAGNETIC RESONANCE IN MICRON AND SUBMICRON AMORPHOUS WIRES

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Micron and submicron amorphous wires are promising for practical use in spintronics, microwave devices and some other applications. Due to their high electrical resistivity and small diameters some peculiar magnetic properties can be observed. In very thin wires, where the electromagnetic penetration depth at microwave frequencies may become comparable or larger than the wire diameter, the microwave properties are strongly influenced by the sample dimensions. Below some critical wire diameter, depending on the applied magnetic field and the frequency, the transition from the properties characteristic for ferromagnetic metals to the properties typical for ferromagnetic insulators is observed.

Ferromagnetic resonance (FMR) in Fe-rich glass-coated amorphous microwires is investigated. A brief review of theoretical predictions for FMR in thin wires is given. For the parallel field configuration (DC magnetic field parallel to the wire axis) a rigorous theory [1], including the exchange coupling and uniaxial anisotropy, is outlined. For the perpendicular field configuration (DC magnetic field perpendicular to the wire axis) only two extreme cases are investigated: the quasistatic or "insulator" limit and the skin-effect or "metallic" limit. For thick wires, where the skin-effect approximation is applicable, the resonance (FMR) and antiresonance (FMAR) fields satisfy the Kittel's resonance conditions for a thin tangentially magnetized film. In very thin wires, where the quasistatic approximation holds, the antiresonance disappears and the Kittel's conditions for the uniform precession FMR mode of a cylinder are valid.

The theoretical predictions are experimentally verified on glass-coated microwires with different metallic nucleus diameters between 0.13 and 25 μm. FMR at room temperature is measured in the parallel and perpendicular field configurations at the microwave frequencies of 49 and 69 GHz. In the parallel field configuration the bulk samples (25 and 14 μm) exhibit single FMR and FMAR peaks satisfying the skin-effect approximation. In the perpendicular field configuration two resonance peaks are observed corresponding to the resonances at the two extreme positions on the wire surface (with surface normal vector parallel or perpendicular to the applied field). For wires with submicron diameters an additional weak FMR peak, corresponding to the insulator mode, can be observed in the parallel field configuration if the sample is placed close to the minimum of microwave electric field in the waveguide. In the perpendicular field configuration an asymmetrical double resonance peak can be found in the submicron wires. The lower part of the double peak is close to the theoretical FMR mode of an insulating cylinder. In agreement with the theoretical prediction the radial standing spin waves are observed in the wire with diameter of 0.53 μm. From the spin wave spectra the exchange stiffness constant $A = 4.6 \times 10^{-12}$ J/m can be calculated.

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MAGNETIC CHARACTERIZATION OF MATERIALS USING FORC TECHNIQUE: QUALITIES AND LIMITS

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Hysteretic behavior is a rather general property documented in many physical processes. Starting from previous studies made on ferromagnetic hysteresis and from the identification technique developed for the Classical Preisach Model by Mayergoyz, it was shown that a set of First-order Reversal Curves (FORC) can provide a general experimental technique to investigate virtually any hysteretic process [1]. When applied to ferromagnetic hysteresis the method can provide essentially the distributions of coercive and interaction fields of the fundamental hysteresis entities, the hysterons that can be associated with real particles or domains from the sample. The FORC diagram method is a very sensitive tool to identify different constituents in a real system and can be used to detect rather small quantities of ferromagnetic material. We present in this context our studies concerning a system of mixture of hard/soft ferromagnetic material (a multilayer system of the form $[Ni/Pt]_6/Pt(x)/[Co/Pt]_6$ in which the coupling between the $[Co/Pt]_6$ "hard layers" and the $[Ni/Pt]_6$ ("soft layers") is adjusted by the thickness x of a Pt interlayer, prepared as presented in [2]). We show the typical features observed on the FORC diagram in this case. However, some of the features observed in these systems are not easy to understand and a supplementary analysis was necessary. What essentially we found is that in some cases the kinetic effects can have a crucial influence on the FORC diagram. This gives us the opportunity to present some of the main problems still to be addressed by the FORC diagram technique in order to become from basically a qualitative method a valuable quantitative method. We shall present the methods for separate evaluation of the reversible and irreversible components on a hysteretic process. A new technique based on the measurement of second order reversal curves (SORC) have shown that the reversible component is coupled with the irreversible component fact which is indicated by an experimentally observed state dependence of the reversible part [3,4]. The Preisach-type model that allow to include all these effects in a consistent way, the Preisach model for patterned media (PM^2) [5], will be also presented in the generalized version (with a state dependent reversible component). Taking into account all the problems evidenced in experiments and in the theories dedicated to hysteresis we shall show also the limits of the FORC method that should be known when a quantitative approach is envisaged.

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NONLINEAR CHANNELIZER FOR RF COMMUNICATION

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The Nonlinear Channelizer is an integrated circuit sized, large parallel array of analog nonlinear oscillators that serve collectively as a broad-spectrum analyzer which can take complex signals containing multiple frequencies and instantaneously lock-on or respond to a received signal in a few cycles. The core technological approach takes advantage of phenomena that are almost universally unique to nonlinear systems: synchronization and coupling topology. These tools are being employed to develop a system capable of locking onto any arbitrary input (RF) signal. The system is efficient, by eliminating the need for high-speed, high-accuracy ADCís, and compact by making use of nonlinear coupled systems to act as a channelizer (frequency binning and channeling), a low noise amplifier, and a frequency down-converter in a single step which, in turn, will reduce the size, weight, power, and cost of the entire communication system. The presentation covers the theory and some engineering details that validate the concept.

INTERPLAY BETWEEN REACTIVITY AND MAGNETISM AT METAL/SEMICONDUCTOR INTERFACES

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Magnetic contacts on semiconductors represent an important topic owing to the possibility of spin-polarized carrier injection. However, it was acknowledged since several decades that such interfaces yield to the formation of a reacted layer with poor magnetic properties, complicated stoichiometry, inhomogenities, the net result being the suppression of spin injection into the semiconductor [1]. Therefore, consistent efforts were dedicated to the improvement of the epitaxy of metal layers and reduction of the reactivity at interface.

This work reviews the interface reactivity studied by photoelectron spectroscopies (X-ray photoelectron spectroscopiy XPS, Auger electron spectroscopy AES) together with magnetic measurements (X-ray magnetic circular dichroism XMCD, magneto-optical Kerr effect MOKE) on several systems, such as: Fe/Si(001), Fe/Si(111), Fe/GaAs(001), Fe/InAs(001), Co/GaAs(011), Sm/Si(001), Mn/Ge(001). Structural data obtained by low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED), X-ray diffraction (XRD), extended X-ray absorption fine structure (EXAFS), X-ray photoelectron diffraction (XPD) will also be used to complete the picture of interface formation.

Some results are as follows: Fe/Si(001) forms a highly reacted interface, forming Fe_3Si when deposited at high temperature; however, when the deposition is carried at low temperature, the reactivity is limited to about 6-7 atomic layers, with subsequent growth of metal Fe with good magnetic properties. In the case of Fe/Si(111) evidence by XPD was found for substitutional placement of Fe into the Si lattice in the second and third atomic layer [2]. Fe/GaAs(001) reacts strongly and has a maximum magnetic moment of 1 μ_B (Bohr magnetons) per Fe atom; in contrast to that, Fe/InAs(001) has a lower reactivity and forms rapidly metal Fe with about 2 μ_B per Fe atom [3]. Co/GaAs(011) stabilizes the *bcc* Co phase with good magnetic properties, when the GaAs(011) surface is previously passivated with a single atomic layer of Sb [4]. Sb also forms a promising magnetic interface on Si(001) [5].

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STRUCTURAL AND MAGNETIC BEHAVIOUR OF HARD/SOFT NANOCOMPOSITE MAGNETIC MATERIALS OBTAINED BY MECHANICAL MILLING*

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Nanocrystalline magnetic materials exhibit magnetic properties which are interesting from a point of view of fundamental research in magnetism as well as for applications. The coupling by exchange interaction at the nanoscale, between soft and hard magnetic phases, leads to "spring magnets" type magnetic nanocomposites [1-3]. Spring-magnets, consisting of a fine mixture of hard (high coercivity) and soft (high magnetization) magnetic phases have attracted attention for potential permanent magnet development. Additionally to the predicted high energy product of 1090 kJ/m^3 [4], the presence of Fe or Fe based phases in exchange spring magnets is promising for better thermal stabilities, higher corrosion resistance and lower prices. The exchange-spring behaviour can be understood on the basis of the intrinsic parameters of the hard and soft magnetic phases which are coupled by exchange interactions.
Our studies include the researches for the optimum coupling in hard-soft composites. These composites are made by co-grinding of bulk intermetallics ($SmCo_5$ or $R_2Fe_{14}B$ previously prepared by induction melting) with Fe or Fe-based alloys powder. The structure and microstructure of milled powders were tailored by different heat treatments. The structural evolution was followed by X-ray diffraction, DSC measurements, Mössbauer spectrometry and electron microscopy. The coercive field, remanence and the degree of hard/soft exchange coupling were studied from hysteresis cycle measurements in magnetic fields up to 12 T and dM/dH function of H curves.

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THE SPIN FLOP EFFECT IN SYNTHETIC ANTIFERROMAGNETS: APPLICATION TO THE ORTHOGONAL PINNING OF MAGNETIC FIELD SENSORS

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A synthetic antiferromagnet (SAF) consists of two ferromagnetic (F) layers antiparallel coupled via a thin metallic nonmagnetic layer. With its closed magnetic flux configuration in the ground state, the SAF provides the advantage of reduced magnetostatic interactions with neighboring F layers. This property makes the SAF structure interesting for many spintronics applications, such us the magnetic field sensors [1], toggle MRAM [2] and more recently, for the spin torque oscillators [3]. The antiparallel magnetic orientation of the SAF is instable at quite low field values. The magnetic moments of the two F layers can flop orthogonal to the external field, similar to the spin flop phenomenon in an antiferromagnetic material. This instability, unwished in the magnetic field sensors, can be removed by pinning the structure with a natural antiferromagnet. However, the same effect is used for the MRAM toggle writing process.

We have studied the spin flop effect in SAFs aiming to induce crossed anisotropies in a sensing device where not only the reference layer is exchange coupled with an antiferromagnetic film, but also the sensing layer [4]. The anisotropy in the soft layer of a magnetoresistive sensor is required in order to avoid the Barkhausen noise during the magnetization reversal. The method consists of controlling the exchange anisotropy direction of the SAF by pinning it in a spin flop state, while the magnetization of the bilayer detection electrode is frozen in the direction of the annealing field.

The analyzed system is a CoFe/Ru/CoFe SAF, exchange coupled with an IrMn film. Using vibrating sample magnetometry and magnetic force microscopy, the main parameters controlling the spin flop process are identified and analyzed such as the annealing field or the RKKY coupling energy between the two F layers. The induced anisotropy is predicted within a theoretical model taking into account the thermal variation of the coupling constants. Finally, the spin flop annealing is used to orthogonally pin the reference and the detection electrodes in an IrMn/CoFe/Ru/CoFe/Cu/CoFe/IrMn spin valve structure. The magnetoresistance of the structure is analyzed as a function of the pinning direction of the SAF acquired during the annealing in the spin flop state.

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INVESTIGATION OF DOMAIN WALL PROPAGATION IN SUB-MICRON GLASS COVERED WIRES BY MAGNETO-OPTICAL KERR EFFECT

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Magnetic materials with outstanding magnetic characteristics and sub-micron dimensionality gained much attention in the last two years [1,2]. A great interest has been paid to the investigation of the domain wall propagation in such ultra-thin wires with sub-micron diameter with potential applications in the field of spintronics and domain wall logic devices [3-5].

In this paper, we have studied the domain wall dynamics in submicron amorphous glass-coated wires by combining two techniques - the magneto-optical Kerr effect (MOKE) used for the investigation of the surface magnetization reversal and surface domain wall propagation and the classical Sixtus-Tonks method for volume domain wall propagation. The domain wall dynamics was studied simultaneously by the two techniques and the magneto-optical Kerr transitions were compared with the signals given by the Sixtus-Tonks pickup coils. Following the synchronization of the two signals and the analysis of the phase shift between the signals we can obtain significant information about the dynamic size and shape of the moving domain wall.

Acknowledgement

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PREPARATION AND MAGNETOELECTRIC PROPERTIES OF $NiFe_2O_4$-PZT CERAMIC COMPOSITES

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Magnetoelectric composites of xNiFe$_2$O$_4$-(1-x)PZT with x=2%, 5%, 10%, 20%, 30% (where PZT=Pb(Zr$_{0.47}$Ti$_{0.53}$)O$_3$) were prepared by citrate-nitrate combustion by using PZT-based template powders. The presence of constituent phases in the composites was confirmed by X-ray diffraction studies. An excellent mixing was obtained in the composite powders, as proved by a detailed SEM-EDX analysis (fig.1). The magnetic properties are derived from the ferrite phase as a sum property and show ferromagnetic/weak ferromagnetic character. The dielectric constant of the composites decreases with the increasing the addition of *x,* as a consequence of the *sum* property. The electrical conduction and dielectric behaviour of the ceramic composites vary with the ratio of the two phases. The dielectric responses show a Debye relaxation in the range of 10^2-10^4Hz and a Maxwell-Wagner relaxation for frequencies below 10Hz (fig.2). The magnetoelectric (ME) coefficient was measured as a function of applied *DC* magnetic field and it increases first and then decreases with increasing the magnetic field. The maximum ME coefficient (dE/dH) varies from 0,0011mV/cmOe to 0.5mV/cmOe with increasing of NFO addition (fig.3).

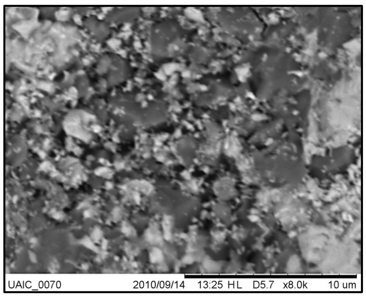

Fig.1 SEM images of the xNF-(1-x)PZT composite with x=0.30 after sintering at 1200^{0}C/1h (white: PZT, grey: NiFe$_2$O$_4$)

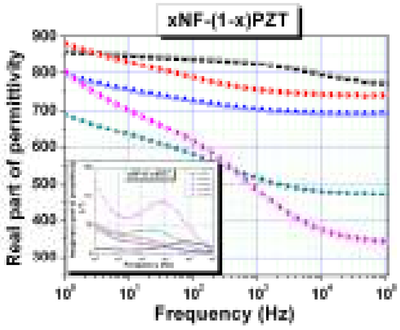

Fig. 2 Real (inset: imaginary) part of permittivity vs. frequency of the xNF-(1-x)PZT composites at room temperature

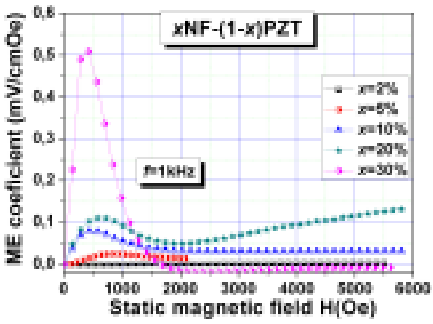

Fig. 3 Magnetic field dependent variation of ME voltage coefficient at room temperature

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MAGNETIC AND DIELECTRIC PROPERTIES OF $Ba_{12}Fe_{28}Ti_{15}O_{84}$ NATURALLY SELF-ASSEMBLED LAYERED CERAMICS

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The BaO-Fe_2O_3-TiO_2 system has a rich crystal chemistry and the existence of at least 16 different quaternary compounds has been reported [1,2]. The quaternary phases are expected to have a high dielectric constant and some of them show a magnetic activity, although a systematic investigation is still lacking.
In this study we report for the first time the magnetic and dielectric properties of the quaternary layered ferrite $Ba_{12}Fe_{28}Ti_{15}O_{84}$. Dense ferrite ceramics were prepared by conventional sintering using powders obtained by solid-state reaction and by coprecipitation. Only the last powder resulted in single phase ceramics, whereas a minor amount of secondary phases were observed in the material obtained by the solid-state route. According to the HRTEM investigation, the ferrite lattice is originated by the intergrowth of perovskite-like and spinel-like slabs, in agreement with previous XRD crystal structure investigations, and can be considered as a natural magnetic superlattice. A ferrimagnetic order with saturation magnetization of ≈13 emu/g and coercivity of ~20 Oe was determined at room temperature, while the thermomagnetic data indicate a Curie temperature of ≈420K. Ceramics obtained by the solid-state route show constricted magnetization loops owing to the presence of a minor, not identified hard magnetic phase and an additional magnetic transition at ~700K. An intrinsic relative dielectric constant of the order of 23-50 at room temperature was measured at 10^9 Hz. At lower frequency the dielectric behaviour is dominated by extrinsic effects related to the heterogeneous electrical nature of the ceramics corresponding to semiconducting grains separated by more insulating grain boundary regions. The dielectric losses are rather high, often >1, indicating an overall semiconducting character of the material.

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HEATING EFFICIENCY EVALUATION OF LOW-Tc GLASSY Fe-Cr-Nb-B MAGNETIC MICROPARTICLES FOR MAGNETIC HYPERTHERMIA

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Today, one of the most challenging and complex research in the medical field is focusing on finding different treatment solutions for malignant processes in mammalians. Apart from the conventional medical methods based on chemotherapy for inducing necrosis of the cancerous cells, methods based on heat generation processes, have started to be developed.
To date, a series of magnetic materials were tested for magnetic hyperthermia [1]. However, new magnetic materials with Curie temperature (Tc) up to 47°C are required for self-regulating magnetic hyperthermia [2]. By using materials with low Tc, the temperature in a target biological tissue can be automatically maintained for unlimited time. Consequently, temperature control and shifting of the AC magnetic field's parameters would not be needed anymore [2]. Here, we report results concerning the heating effectiveness of glassy $Fe_{67.7}Cr_{13}Nb_{0.3}B_{20}$ magnetic microparticles with low Tc, and iron oxide nanoparticles, respectively. The thermo-magnetic loop of the $Fe_{67.7}Cr_{13}Nb_{0.3}B_{20}$-based magnetic materials shows a Tc of about 53°C (fig. 1). This behavior reflects in the profile of the curve that shows time dependence of the temperature.

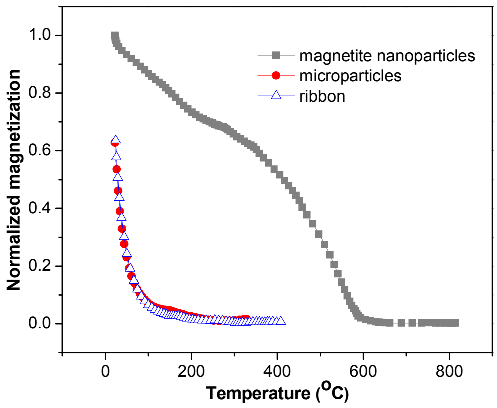

Fig. 1 Thermo-magnetic loops of samples.

A maximum constant temperature of 44°C was reached by using magnetic microparticles after approximately 1h, whereas for iron oxide nanoparticles, a temperature higher than 70°C was recorded in few minutes. The glassy $Fe_{67.7}Cr_{13}Nb_{0.3}B_{20}$ magnetic microparticles can be used for magnetic hyperthermia, whereas iron oxide nanoparticles can be used for thermo-ablation of cancerous biological tissues.

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STRESS DEPENDENCE OF THE SWITCHING FIELD IN GLASS-COATED MICROWIRES

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Amorphous glass-coated microwires are ideal material for micro-sensing element for various applications. Microwires with positive magnetostriction show bistable behavior (e.g. the magnetization can have only two values + M_s and -M_s) [1]. The switching between two magnetization values appears at the switching field at which the magnetization process runs through the single Barkhaussen jump. As the main anisotropy that determines their magnetic properties is magnetoelastic one [2], the switching field is strongly dependent on the mechanical stress.
In the given contribution, we have studied the stress dependence of the switching fields in the glass-coated FeNbSiB microwire. We show that the stress dependence can be tailored by properly choosing the frequency of exciting magnetic field (Fig. 1). At low frequencies, the switching field is weakly dependent on the mechanical stress, which is ideal for sensors of magnetic field or temperature. Increasing the frequency, the stress dependence of the switching field increases. The slope of the stress dependence is almost linear and the switching field increases its value from 128 A/m at 0 MPa to 242 A/m at 160 MPa.

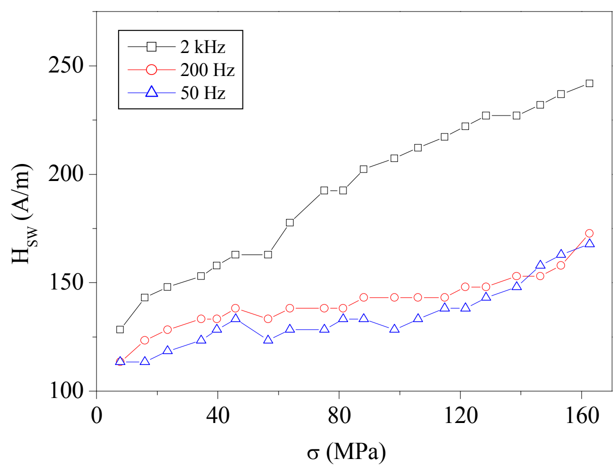

Fig.1: Stress dependences of the switching field measured at various frequencies of the applied magnetic field.

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MAGNETOELASTIC AND MAGNETOSTATIC ANISOTROPY IN RAPIDLY SOLIDIFIED AMORPHOUS NANOWIRES

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Amorphous nanowires and submicron wires with diameters between 90 and 900 nm have been recently prepared by rapid solidification [1,2]. Besides the advantage of having extremely long single nanowires available for various studies, these materials are also important from the practical point of view. In order to employ these novel materials in magnetic sensors and other applications, it is essential to understand the origins of their magnetic behavior starting with magnetic anisotropy and domain structure.

Their magnetic behavior is decided by the interplay between magnetoelastic anisotropy and shape anisotropy. The former arises from the magnetomechanical coupling between internal stresses induced during preparation and magnetostriction, whilst the latter becomes important as the diameter decreases.

Results of a systematic study of the magnetic anisotropy and domain structure of amorphous nanowires as a function of their dimensions are reported. The analysis is based on the calculation of internal stresses induced during preparation. The magnetoelastic term is then analyzed against the magnetostatic term in order to determine the preponderant energy term.

In a 350 nm $Fe_{77.5}Si_{7.5}B_{15}$ wire the minimization of the magnetoelastic term would lead to a core-shell domain structure, however, the increase in the magnetostatic energy would be very large, and therefore the formation of a single domain structure is favored. A similar situation was found in a much thinner sample (160 nm in diameter), characterized by a mixed stress distribution. The important role of shape anisotropy has been shown for even thinner samples, e.g. nanowires with 134 nm in diameter. In such samples, both the magnetoelastic term and the shape anisotropy would lead to a single domain structure. Therefore, the switching field was calculated to prove that shape anisotropy is responsible for the single domain. The hysteresis loops of nanowires with the glass coating partially or fully removed support the calculated results.

Thus, shape anisotropy accounts for the formation of the single domain structure and for the characteristics of the magnetization process in all the wires with diameters below 350 nm. Magnetoelastic anisotropy plays an important role in thicker wires. The results are in agreement with previous experimental results obtained from ferromagnetic resonance measurements.

Acknowledgment

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GIANT MAGNETO-IMPEDANCE EFFECT IN RAPIDLY SOLIDIFIED NANOWIRES

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The giant magneto-impedance (GMI) effect consists of a significant change in the impedance of a magnetic material in which a high frequency current is passing when it is subjected to a static magnetic field [1]. The magnetic amorphous wires with nearly zero magnetostriction display a high sensitivity of the GMI) effect, which makes them promising for magnetic sensor applications. The GMI effect in rapidly solidified amorphous glass-coated microwires, having metallic nucleus diameters between 1 and 50 μm was extensively studied during the last decade.

The successful preparation of rapidly solidified amorphous glass-coated wires with sub-micrometric metallic core diameters has been recently reported [2,3]. These new materials have opened up a new perspective for further miniaturization of the GMI sensors based on microwires.

The aim of this paper is to present for the first time the effect of the sample core diameter on the GMI effect in the submicron glass-coated amorphous wires. The glass-coated wires with diameters down to 100 nm have been prepared using a modified Taylor-Ulitovsky technique. The samples where characterized from the point of view of the GMI effect at frequencies up to 3 GHz using an Agilent E4991A impedance analyzer and a specially designed sample holder.

Acknowledgements

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THE TEMPERATURE FIELD IN THE PULSED LASER HEATED MAGNETIC NANOWIRES

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In the last years, the interaction between magnetic nanowires and laser light becomes an increasing important topic [1]. Study of the thermal stability in the magnetic nanowires during laser-induced heating presents a special interest for technological applications as heat assisted magnetic recording (HAMR) [2]. The main goal of this paper is to describe the thermal field produced by a laser light pulse in a magnetic nanowire system. It was proposed a two - dimensional analytical model that predicts the spatio-temporal temperature distribution in the magnetic nanowire during laser-induced heating. Considering the laser light as a heating source - applied at the end of a magnetic nanowire included into a membrane, the spatio-temporal evolution of the temperature was obtained by solving the time - dependent heat conduction equation with proper thermal boundary conditions. The temperature distribution and consequently, the thermal stability of the nanowire depend on its size parameters (radius and length) and laser power. It is observed an increase of the temperature in time do to the laser heating, the temperature distribution along wire axis having a decrease.

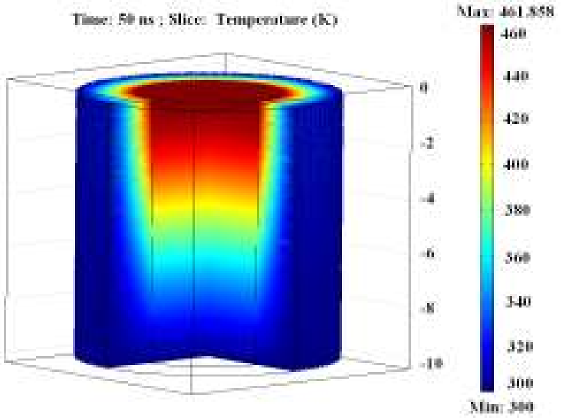

Fig. 1 The spatio-temporal evolution of temperature for a nanowire with a length L = 10 nm and a radius R = 6 nm in a membrane with a thickness $\delta R = 3\,nm$

The values of temperature given by the analytical model were compared using a numerical finite element method in Comsol. The magnetic behavior of the nanowire was analyzed using the Micromag application. The results presented in this paper show that by changing the values of the size parameters of the nanowire and laser power, the thermal and magnetic stability of the system can be controlled.

Acknowledgement

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MAGNETOSTATIC INTERACTIONS IN ARRAYS OF ELECTRODEPOSITED NANOWIRES INVESTIGATED BY MAGNETO-OPTICAL KERR EFFECT

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Nanowires are remarkable structures for high performance devices, as their extremely small sizes, shape anisotropy and high surface to volume ratios provide them with unique physical properties that can be used for sensor, logic and memory functions. Magnetic multilayered nanowires such as Py/Cu are potential candidates for magnetic sensors, high density magnetic data storage and magnetoelectronic/spintronic applications [1,2].

The magnetostatic interaction between nanowires mainly decides their collective magnetic behavior. The corresponding term is very complex and it accounts for both the interaction between nanowires within the system and for the interaction within each nanowire from the array.

We report results on a novel approach used to investigate the magnetostatic interactions in electrodeposited Py and Py/Cu nanowires. They have been investigated by means of magneto-optical Kerr effect (MOKE) using a NanoMOKE II magnetometer, produced by Durham Magneto Optics, Ltd. MOKE is optimum for studying the local effects of interaction within the nanowires from the array.

The MOKE surface hysteresis loops have been measured on nanowires placed in various configurations. The nanowires have been released from the template using a concentrated solution of NaOH, followed by final ultrasonic cleaning. Individual nanowire samples have been placed next to each other in groups of 2, 3 and 4 samples.

The obtained results show that the characteristics of the surface hysteresis loops strongly depend on the diameter of the nanowires, their composition, the thickness of the layers composing the multilayered nanowires and the number of nanowires measured together.

Acknowledgement

Work supported by the Romanian Ministry of Education, Research, Youth and Sports through the NUCLEU Program (Contracts No. 09-43 N, 01 02 and 02 02).

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SIZE EFFECTS IN THERMAL TRANSITION OF SPIN CROSSOVER NANOPARTICLES STUDIED BY AN ISING - LIKE MODEL

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Spin transition materials are photo-magnetic molecular compounds made by synthesis chemistry in form of monocrystals and crystallites powder which have two states in thermodynamic competition, a low spin state (LS) S=0 and a metastable high spin state (HS) S=2. The spin transition is a first order phase transition produced by variations of temperature, pressure or light. Spin transition materials are studied for fundamental research and for future applications as candidates for recording data at molecular level, as optical memories, and also for numerical display. In this paper we study the role played by size effects in thermal transitions of modern nanostructured spin crossover compounds and we show the role played by edge effects. The computational results are obtained after extensive simulations based on an Ising like model with long- and short-range interactions, in open boundary conditions or in polymer bordered spin crossover lattice (Fig. 1), and they respect the most recent experimental data of spin transition nanoparticles behavior.

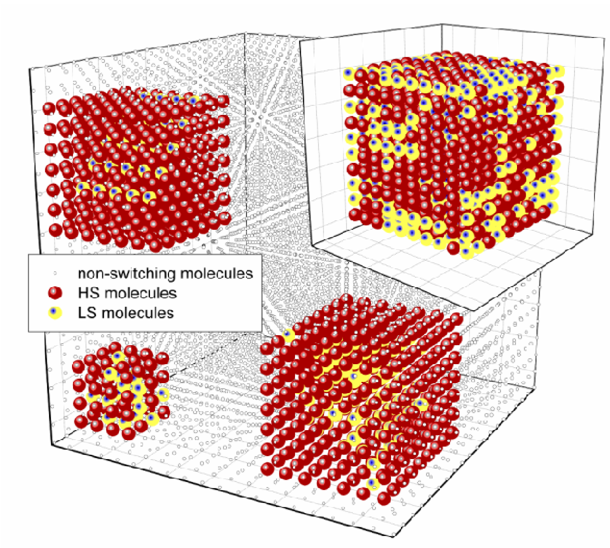

Fig. 1. Snapshots of spin crossover rectangular nanoparticules taking during the thermal transition when 75% of molecules are HS (big spheres: red: HS molecules, yellow LS molecules) embedded in non-switching molecules (small spheres). Inset: Open boundary system in a similar case

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LLG STUDY FOR THE TRANSVERSE SUSCEPTIBILITY DETERMINATION IN THE FERROMAGNETICS PARTICLES SYSTEM

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Transverse susceptibility (TS) is a reliable method for the determination of anisotropy in nanoparticulates media. To correctly evaluate the value of anisotropy in various modern nanostructured materials, a number of theoretical problems related to the method have to be understood to avoid significant systematic errors. In this work we propose to study the transverse susceptibility tensor of a one and two ferromagnetic particle system in Stoner – Wohlfarth model.

The starting point of this work is the magnetization's equation of motion Landau-Lifshitz-Gilbert for one and two particles in Stoner-Wohlfarth model, with uniaxial anisotropy. By solving the inhomogeneous system of linear equations on the magnetization's spherical coordinate deviations, the susceptibility tensor of one and two particles system (with exchange interactions) is obtained.

In a susceptibility experiment it is required to apply two magnetics fields, a dc bias field H_{dc} which can be varied in a quite large range, and a small perturbing ac field h_{ac} and the magnetization variation is measured. The susceptibility is usually measured as the amplitude ratio of the first harmonic of the induced magnetization along a given direction and that of the ac field.

In order, to determine the angles which describe the dynamics of magnetization vector, here can be two may of solving the system of equation: an analytical one and a numerical (micromagnetic) one. We shall therefore present the two solving methods, and in the end, we shall compare the results obtained for the transverse component of the susceptibility on the alternative field direction

The comparison of the results obtained by analytical and numerical integration of the LLG equation, was a test for the micromagnetic program.

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IDENTIFICATION TECHNIQUE FOR PREISACH-TYPE MODELS APPLIED TO STRONGLY INTERACTING SYSTEMS

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The patterned media are seen as strong candidates for the ultra-high density recording media of the future. In order to assure robust reading/writing procedures a profound knowledge of the magnetization processes is required. This implies the correct evaluation of both reversible and irreversible components of the magnetization during the mentioned procedures.
A good choice for a model that can include successfully the complex behavior of a magnetic system is given by Preisach-type models [1-2]. Starting from the well-known Classical Preisach Model (CPM), a number of improved versions have been developed successively that are now used to reproduce the magnetization processes of various magnetic systems.
To describe the systems with strong interparticle interactions the Preisach Model for Patterned Media (PM2) [3] was developed. The PM2 model is able to include bimodal interaction field distribution which is specific to the strongly correlated systems of ferromagnetic nanoparticles.
Recently a realistic form of the reversible part was also included in the PM2 model and it was demonstrated model's capacity to describe correctly higher order magnetization curves [4]. The identification technique for this version of the model includes First and Second-order Reversal Curves (FORC and SORC) and a special technique to obtain the bimodal reversible part of magnetization [5].
In this paper we analyze the systems with strong interactions from the point of view of the optimal identification of parameters. If in a Moving Preisach Model we work in the operative plane one expects that the Preisach distribution in this plane is the "real" distribution characterizing the irreversible switches. However, in strongly interacting systems one can observe that the moving approximation is no more sufficient. One can evaluate an effect of the variable variance that has to be taken into account in the calculation.
Also we will present a technique of identification that can be extended to strongly interacting systems and nanostructures. That can be applied especially to perpendicular media including the bit patterned media.

Acknowledgement
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A STUDY OF THE FLUCTUATION FIELD USING AN ISING-PREISACH MODEL

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We developed a modified version of the Ising model based on the concept of Preisach rectangular hysteron [1]. We present an Ising-type numerical simulation of relaxation isotherms for an ensemble of thermally activated, two-level subsystems. Magnetic viscosity experiments performed on particulate media, with particle dimensions ranging from microns to nanometers, measure the decay of the moment after recoiling from positive saturation to negative holdings fields $-H_a$ in the vicinity of the measured coercive field H_c when the temperature and the field are fixed. The comparison between the system with interaction and the system without interaction was made. Relaxation in recording-type media shows a complex behavior (Arrhenius and non-Arrhenius relaxation processes) [1-2].

Acknowledgement
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MICROMAGNETIC INVESTIGATION OF SWITCHING BEHAVIOR OF SYNTHETIC ANTIFERROMAGNETIC DOTS

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Synthetic antiferromagnetic (SAF) coupled films have been extensively studied having in mind technological applications like underlayers for perpendicular recording media [1], spin valves for magnetic read heads and sensors [2] or components of MRAM cells [3].
One of the most important aspects of the magnetic characteristics of SAF layers, their switching behavior, have been systematically studied in terms of static and dynamic switching critical curves using the single domain approximation [4].
In thispaperwe propose a study of the influence of non-coherentswitching modes on the performance of SAF devices.
For the simulations we have used the open-source finiteelementmicromagnetics package magpar [5] customized in order to includeinterfacialcoupling.
The samples have ellipticcylindershapewith 120nm/100nm axes, differentthickness values for the twoferromagneticlayers and in-planeuniaxialanisotropy. Both hard and soft magneticmaterials have been considered for the twolayers.

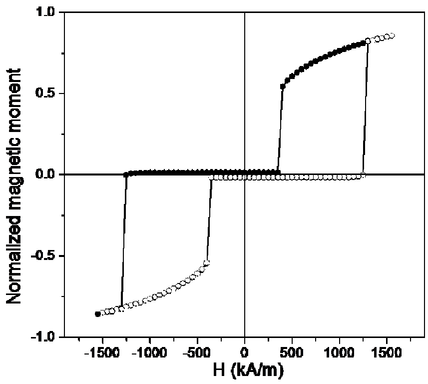

Fig. 1 Typical major hysteresisloop for a 11.5 nm thick SAF device. AF=1.0e-11 J/m, AAF=-5.0e-12 J/m, K1=4.0e5 J/m3, JS=1.0 T

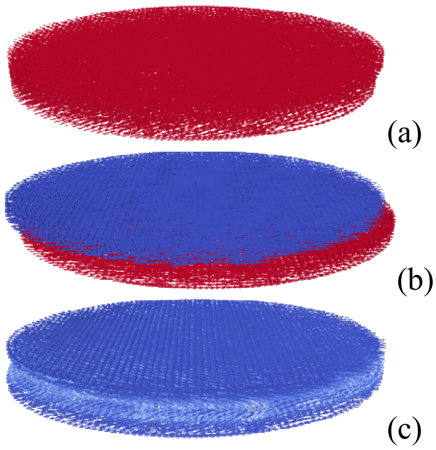

Fig. 2 Intermediatemagnetic states in different point of the MHL

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NONPARAMETRIC IDENTIFICATION PROCEDURE FOR PREISACH MODEL FOR PATTERNED MEDIA (PM^2)

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The magnetic behavior of ferromagnetic media is essentially influenced by the magnetic interactions between the entities from the system. The behavior of an ensemble of particles will display hysteresis that will be controlled not only by the hysteretic properties of each particle, but also by the interactions between the magnetic moments and by the individual coercive field of the particles.

For better describe real magnetic systems, many Preisach-type models have been developed, with the origin in Classical Preisach Model (CPM). We mention here the well known Moving Preisach Model (MPM) that adds a mean interaction field which moves the distribution during the magnetization processes [1], and the Variable Variance Preisach Model (VVPM) that takes into account the dependence of the interaction field distribution variance versus the magnetic moment of the sample [2].

The Preisach Model for Patterned Media (PMPM = PM^2) was developed to simulate magnetization processes in strongly correlated particulate media with a high degree of order [3]. For these samples the interaction field distribution has a distinctive bi-modal shape which is dependent on the total magnetization of the sample. Our identification technique for this version of the model includes First Order Reversal Curves (FORC) and a special technique to obtain the bi-modal irreversible Preisach distribution.

It is known that the PM^2 model includes as particular cases both the MPM and the VVPM for weak interactions. If, for example, in a Moving Preisach Model we work in the operative plane one expects that the Preisach distribution in this plane is the "real" distribution characterizing the irreversible switches. To improve our procedure, we also take into account the dependence of the distribution variance by the magnetic moment of the sample.

Acknowledgment

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Fe_3O_4 CORE - MCM-41 SHELL NANOPARTICLES: SYNTHESIS AND CHARACTERIZATION

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During the last decade magnetic nanoparticles have attracted a special attention not only for their interesting magnetic properties but also for their potential applications. Among all the studied magnetic nanoparticles, magnetite (Fe_3O_4) is one of the most investigated due to the broad range of potential applications [1]. The chemical stability is a crucial requirement in any application of magnetite nanoparticles and consequently strategies to improve the stability of magnetite nanoparticles are required. The most effective method usually considered is the coating with a protection layer.

In this paper we report the synthesis of core-shell type composite consisting of magnetite nanoparticles coated with ordered mesoporous silica (MCM-41) shell. The mesoporous silica-coating of magnetite nanoparticles where performed under ultrasonic irradiation. Ultrasonic irradiation was used to accelerate the polycondensation reactions of the silicate species around structure-directing agent micelles thus leading to the formation of the MCM-41 framework. The X-ray diffraction result indicates that the extreme conditions created by acoustic cavitations have an insignificant effect on crystallographic structural characteristic of magnetite nanoparticles. Changes in the coercivity distributions of the magnetite nanoparticles were observed on the First - Order Reversal Curves (FORC) diagrams (Figure 1) for the samples with coated particles compared with the samples containing uncoated particles of magnetite. The coated particles show an increased most probable coercivity of about 20% compared with the uncoated particles which can be associated with an increased anisotropy due to coating even if the interaction field distribution measured on the diagrams are virtually identical for coated/uncoated samples.

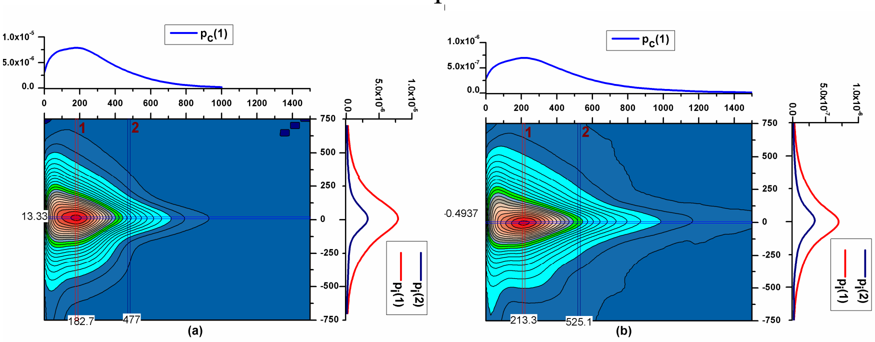

Fig. 1. FORC diagrams obtained for (a) uncoated and (b) coated magnetite nanoparticles.

Acknowledgements:

This work was financial supported by POSDRU/6/1.5/S/25 and POSDRU/89/1.5/S/49944 in Romania.

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SYNTHESIS, FUNCTIONALIZATION AND CHARACTERIZATION OF OCTAHEDRAL IRON OXIDE NANOPARTICLES VIA A HYDROTHERMAL ROUTE

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In the relative recently emerged nanotechnology field, among a series of new or improved performance materials and devices, the nanoparticles have undoubtedly become key structures for many industrial and biomedical areas.
In the biomedical field, magnetite and maghemite nanoparticles are being the most used magnetic nanomaterials. Apart from their strong magnetism, both magnetite and maghemite were shown to be biocompatible, being very attractive for different biomedical applications.
To date, various physical, chemical and biological methods for magnetic nanoparticle synthesis have been developed [1-2]. Among them, the hydrothermal route is the most used.
Here we report a new method for preparation of iron oxide nanoparticles, especially magnetite, with controlled magnetization by using a chemical method.
Iron oxides with sizes between 10 – 300 nm (fig. 1) and magnetization between 20 – 85 emu/g are obtained. Generally, the nanoparticles show an octahedral profile which is the specific shape of the natural magnetite.

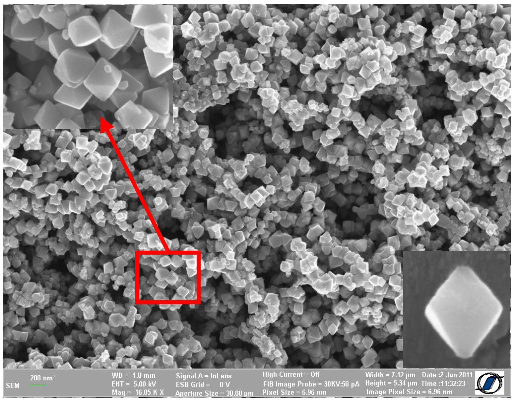

Fig. 1. SEM image of octahedral magnetite.

The magnetic nanoparticles were subsequently surface functionalized with 3-aminopropyl-triethoxysilane.
The iron oxide nanoparticles can be used in a functionalized or non-functionalized state for different biomedical applications.

Acknowledgements
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SYNTHESIS OF MAGNETITE NANOPARTICLES UNDER A MICROWAVE FIELD USING ORGANIC FERROUS SALTS

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Magnetite nanoparticles have been widely studied because of their potential applications in various fields such as biotechnology, bioanalysis, clinical diagnosis and treatment, magnetic inks, etc. To date, there are known and described several procedures for the preparation of magnetite, based on chemical precipitation, physical and electrochemical methods, or combined methods. Several authors have prepared magnetite nanoparticles by thermal decomposition of iron organic compounds [1-3]. The size and shape of particles differ, depending on the selected precursor.

The present paper deals with the preparation of magnetite nanoparticles using ferrous oxalate as source of Fe ions, and urea as a generator of OH^- ions. Ferrous oxalate has the advantage that is poorly soluble in water, so when the temperature increases it provokes the gradual release of Fe^{2+} ions in solution. Using an organic reagent, urea, as a retardant precipitating agent, OH^- ions are gradually released into the solution due to the hydrolysis reactions. At a high concentration of OH^- ions into the solution, Fe^{2+} ions are partially oxidized to Fe^{3+}, so Fe ions coexist in both oxidation states, a condition required for magnetite formation. The chemical synthesis was done in a microwave field using a programmed temperature regime. Compared with other conventional techniques, this method offers many advantages: homogenous heating of the reaction medium, homogenous nucleation and reduced time of crystallization, simultaneous introduction of reagents without the need for stirring, total lack of pollution.

The obtained magnetite nanoparticles have mean sizes of 17-20 nm and specific saturation magnetization between 42.3 and 65 emu/g, depending on the programmed temperature regime. FT/IR analysis performed to characterize the surface of the magnetite nanoparticles indicated the presence of the absorption bands assigned to C=O and NH_2 groups, thus the possibility of obtaining functionalized magnetic nanoparticles capable to bind bioactive components, dyes, etc.

Acknowledgment

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SOLID-PHASE EXTRACTION OF SOME AZO-DYES FROM ENVIRONMENTAL WATER SAMPLES USING ANIONIC MAGNETIC CLAYS

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Azo dyes play an important role as coloring agents in the textile, food and pharmaceutical industry. These dyes are toxic and carcinogenic and have a great influence on photosynthetic activity in aquatic medium. Water soluble acid dyes are characterized by low biodegrability, and are not easily removed from wastewaters by conventional physico-chemical coagulation methods. Therefore, there is a growing interest in finding low-cost, easily available material for the dyes removal [1-3].

Layered double hydroxides (LDHs) are an important class of anionic lamellar solids which have received considerable attention in the last years, because of their potential applications such as ion-exchangers, catalyst supports, antiacids and sorbents for organic solutes, and particularly for negative charged species. The dye intercalation into the gallery of the LDHs may be realized by co-precipitation, anionic exchange, or by reconstruction method, based on structural "memory effect".

In the present work we describe the removal of two azo-dyes: Acid red G and Methyl red, from water samples, by extraction on LDHs-Fe_3O_4 solid phase. The precursor clays ZnAlLDH and MgAlLDH prepared by co-precipitation method and calcined at 550°C, were put into contact with an aqueous suspension containing $NaNO_3$ and magnetite. Thus, the initial structure of the LDHs was regenerated; water is adsorbed to re-form the hydroxyl layer, while Fe_3O_4 and NO_3^- anions are incorporated into the interlayer galleries. The obtained composites, with magnetic behavior, are able to extract the acid dyes from water samples by anionic exchange process.

We studied the influence of the solution pH, contact time, temperature, and initial dye concentration on adsorption capacity. The maximum amount dye uptake at 25°C using ZnAlLDH-Fe_3O_4 was 170 mg/g for Acid red G, and 123 mg/g for Methyl red, the contact time being of 120 min. Using MgAlLDH-Fe_3O_4, the maximum amount of Acid red G retained was 159 mg/g, whilst 132 mg/g of Methyl red were extracted. These values are higher than those obtained, under the same conditions, using non-magnetic anionic clays, leading to the conclusion that magnetite improves sorption capacity of the studied dyes.

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DAMPERS BASED ON MAGNETORHEOLOGICAL FLUIDS FOR VIBRATION CONTROL

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The control of the vibration produced by different machines or bodies is often needed in many applications so that solutions based on active or semi-active dampers are needed. In order to design and build a damper with dynamic attenuation factor an active media with variable viscosity is needed. Such media are the magnetoreological fluids which display, by applying a magnetic field, the largest variation of the viscosity compared to other media with variable viscosity. Thus, the magnetoreological fluids are the most suitable fluids for a damper with semi-active control.
The control of the damping force in dampers with magnetoreological fluid is achieved through the magnetic field with variable intensity. By applying a magnetic field, the rheological characteristics of the working fluid inside the damper changes thus adjusting the damping force.
In our laboratory we designed and built a damping system based on magnetorheological fluids aiming to test our magnetorheological fluids and to evaluate their ability to work in vibration control applications. Also a study is made upon the damper system in order to improve it in terms of performance, dimension, and weight. The testing system comprises also vibration machine and measuring devices.
The following curves are measured for the purpose of our study: damping force - velocity, damping force – displacement, transmissibility – frequency.

Acknowledgment

Work supported by the Romanian Ministry of Education, Research, Youth and Sports under contract PN 09-43 02 04.

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DESIGN OF NANOSTRUCTURES AND NANOCONTACTS FOR SENSING APPLICATIONS USING FOCUSED ION BEAM

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The interdisciplinary field of materials science and in particular the applications based on sensors is permanently seeking to image and analyze on a smaller and smaller scale for a more complete understanding of materials structure – composition – processing – property relationship and further to design smaller, more performing, less energy consuming sensors and applications based on sensors. The ability to conduct material fabrication through precise micro- and nano-machining has become imperative to the progress of sensors and sensing applications and within these fields to the realization of nanocontacts between the nanostructures and the bigger elements of the application.

An important tool that successfully meets these challenges is the focused ion beam (FIB) system. This technology offers unsurpassed opportunities of direct micro- and nano-scale deposition or material removal anywhere on a solid surface. These capabilities broadened the range of potential nanotechnology and sensing applications.

We are presenting here our work on the design of nanostructures and nanocontacts for sensing applications by means of focused ion beam technique.

Acknowledgment

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HIGH FREQUENCY MAGNETIC PROPERTIES OF NANO - PATTERNED MEANDER STRUCTURES

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The dynamic magnetization processes which take place at high frequencies, such as those associated with the giant magneto-impedance (GMI) effect and ferromagnetic resonance (FMR), have been extensively studied in Co-based amorphous ribbons, wires, microwires, thin films and nanowires, and found to be suitable for various sensor applications [1]. On the other hand, the investigation of the GMI effect and FMR in micro-patterned Co-based amorphous ribbons has been recently reported [2].

The aim of this paper is to report results on the effect of sample geometry on the dynamic magnetization processes which occur at high frequencies in smaller sized Co-based nano-patterned meander structures. CoFeSiB nano-meanders with different characteristics have been prepared by means of Electron Beam Lithography on thin films deposited by RF sputtering.

Meanders with one and three turns have been measured, with the applied magnetic field oriented either along the length of the meander or perpendicular to the plane of the meander. GMI measurements have been performed using a vector network analyzer (VNA) at frequencies of the driving ac current between 100 MHz and 10 GHz. FMR measurements been performed using an X-band spectrometer.

Acknowledgement

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SELECTIVE MICROWAVE ABSORPTION PROPERTIES OF CoFe - BASED GLASS - COATED AMORPHOUS MICROWIRES

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Electromagnetic shielding is currently viewed as a critical problem concerning the security of electronic equipment which is highly sensitive to interference with electromagnetic fields in the microwave frequencies range [1], as well as the biological protection by the maximum reduction of the effects of electromagnetic radiation on living organisms.
The aim of this paper is to report results on the selective microwave absorption properties of individual and multiple CoFe-based glass-coated amorphous microwires (GCAW) with nearly zero magnetostriction ($\lambda \cong -1 \times 10^{-7}$) positioned in various configurations.
The GCAW have been prepared by the Taylor-Ulitovsky technique as continuous filaments with the diameter of metallic nucleus ranging from Φ_m = 6 μm to Φ_m =24 μm, glass thickness ranging from G_{th} = 7.25 μm to G_{th} = 27.5 μm. The GCAW samples were cut at lengths ranging from L = 12 mm to L = 50 mm and were glued in various configurations on sheets of paper to form a wire-lattice of 20 × 25 cm^2.
The largest absorption was observed for the sample with the largest circumferential anisotropy in the surface region [2], [3], i.e. in this case the sample with the thickest glass coating (27.5 μm) and the largest ratio between the glass coating thickness and the radius of the metallic nucleus (3.06 μm). The sample length allows one to control the absorption frequency. A field tunable effect of 3.2 dBm, which corresponds to ΔF = 0.82 GHz, was achieved for a wire-lattice with 4 cm length, in comparison with 2.34 dBm, which corresponds to ΔF = 0.58 GHz when the external magnetic field changes from zero to 14.5 Oe.
The obtained results are useful for the development of tunable electromagnetic shielding devices based on amorphous glass-coated microwires.

Acknowledgement
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FeCuNbSiB/CoPt(Cu) MAGNETIC MICROWIRES

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A new family of microwires in which glass-coated amorphous microwires, subsequently coated with non-magnetic and/or magnetic layers lead to interesting applications of microwires as multifunctional sensors [1]. A very interesting hard magnetic material which can be used for coating the soft magnetic glass-coated microwires is the CoPt alloy which was intensively studied for applications in perpendicular high density magnetic media, magnets for small electronic devices, biosensors, cell separation, etc. It was found that the addition of a small amount of Cu or the deposition of a Cu underlayer reduces the annealing temperature for which the optimum hard magnetic are achieved, from between 650-750°C down to 450°, depending on Cu concentration [2].

The work presents results on the magnetic behaviour of new multilayer microwires consisting of FeCuNbSiB glass-coated microwires (8 μm metallic diameter, 13 μm thickness of glass cover) subsequently coated by RF sputtering with 640 nm CoPt, Cu/CoPt, and CoPtCu films, respectively. Their magnetic behaviour was tailored in such a way to take advantage of the structural characteristics simultaneously induced both in the soft magnetic nucleus and in the CoPt-based layers by thermal treatments.

Nanocomposite films consisting of CoPt nanograins with a high magnetic anisotropy L10 structure and (001) texture have been prepared to study the structural and magnetic phases evolution by X-Ray diffraction measurements with Cu-Kα radiation.

The magnetic measurements on the multilayered microwires have been performed using the fluxmeter method at relatively low applied fields of up to 3kA/m, and using a VSM Lakeshore 7410 system in a maximum applied field of 1600 kA/m.

The hysteresis loops confirm the existence of two magnetic phases, corresponding to the ultrasoft FeCuNbSiB and hard CoPt magnetic materials. Since the CoPt layer is relatively small, the main contribution is given by the soft magnetic nucleus. The Cu addition lead to the reduction of the annealing temperature at which the optimum hard magnetic properties occur in the CoPt alloy to less than 600°C, temperature which is close to the optimum annealing temperature at which the nanocrystalline phase in the FeCuNbSiB microwire is formed. Thus, a multilayer material consisting of a very soft magnetic nucleus and a hard cover separated by the insulated glass shell has been produced in a one step thermal treatment.

The obtained results are interpreted considering the magnetic interaction between the soft and hard magnetic phase, especially after annealing. The observed magnetic behaviour makes these materials potential candidates for applications in magnetic sensors.

Acknowledgment

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FeCuNbSiB THIN FILMS DEPOSITED BY HIPIMS: ANNEALING INFLUENCE ON THE STRUCTURAL AND MAGNETIC PROPERTIES

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Thin films deposition techniques as sputtering and pulsed laser deposition are excellent methods for amorphous materials production [1-4].
FeCuNbSiB thin films with thickness between 200 nm and 500 nm have been deposited on glass substrates, by high power impulse magnetron sputtering (HiPIMS) from ribbons with the nominal composition Fe73.5Cu1Nb3Si15.5B7 (Vacuumschmelze GmbH). The deposition was performed in argon atmosphere, using a constant argon flow of 20 sccm, the base pressure in the chamber being 2·10−6 torr. The power pulse width was 4 μs and the repetition pulse frequency was 1 kHz.
The samples have been investigated in as-deposited state and after furnace annealing in vacuum (10−6 torr), for 1 hour, at temperatures between 340^0C and 525^0C.
The X-ray photoelectron spectroscopy investigation demonstrates that the surface chemical composition of the films was essentially the same as the target composition.
The samples structure investigated by X-ray diffraction technique shows that in as-deposited state the samples are amorphous and exhibits a halo typical of amorphous phase. After annealing at temperatures higher than 4000C, α-Fe(Si) grains start to nucleate, the grain sizes varying from 2 nm to 18 nm when the annealing temperature increases up to 525^0C.
The magnetic behaviour was investigated by a differential inductive method at 50 Hz, using an integrating fluxmeter. The lowest coercive magnetic field was obtained after annealing at 475^0C. The further increase of the annealing temperature determines the coercive magnetic field increment.

Acknowledgments
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COMPOSITION CONTROL AND MAGNETIC PROPERTIES OF CoFeSiB THIN FILMS PREPARED BY CO-SPUTTERING METHOD

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Today, large efforts are carried out to develop CoFeSiB thin films because of their promising applications as active components for various magnetic devices [1]. Recently, the use of CoFeSiB amorphous thin films was proposed as an alternative to the conventional CoFe crystalline films in magnetic tunnel junction (MTJ) structures for magnetic random access memory (MRAM), since amorphous CoFeSiB provides better magnetic properties than CoFe [2]. However, the magnetic properties are very sensitive to composition. Since the composition of sputtered thin films deviates from that of the alloy target, the control of the thin films' composition is extremely important in the deposition process [3].

In this paper, some results concerning the effect of the sputtering power density on magnetic properties of CoFeSiB thin films prepared by co-sputtering are reported. We present a co-sputtering process which allows a precise tuning of the composition of CoFeSiB films, by varying the sputtering power density for the Co target. We used the simultaneous deposition from four targets, the power of each target being controlled independently. By varying the sputtering power density for the Co target and keeping the power density for Fe, Si and B constant we have prepared thin films with different compositions. The films' composition was varied from $Co_{63.1}Fe_{8.8}Si_{16.4}B_{11.7}$ (for 4.2 W/cm^2 power density) to $Co_{79.7}Fe_{4.3}Si_{9.2}B_{6.8}$ (for 7 W/cm^2 power density). The films prepared at the lowest sputtering power density (4.2 W/cm^2) present a coercive field H_c = 3 Oe and a saturation magnetization M_s = 128 emu/g. By increasing the sputtering power density to 7 W/cm^2 the coercive field increases up to H_c = 80 Oe, while the saturation magnetization increases up to M_s = 140 emu/g. All films have been deposited on glass substrates with thicknesses of 160 nm.

Thus, by varying the sputtering power density for Co deposition it is possible to tailor easily the composition and magnetic properties of CoFeSiB thin films.

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STRUCTURE, MAGNETIC PROPERTIES AND THERMAL STABILITY OF NANOCRYSTALLINE NdFeB FILMS WITH REFRACTORY METAL ADDITIONS

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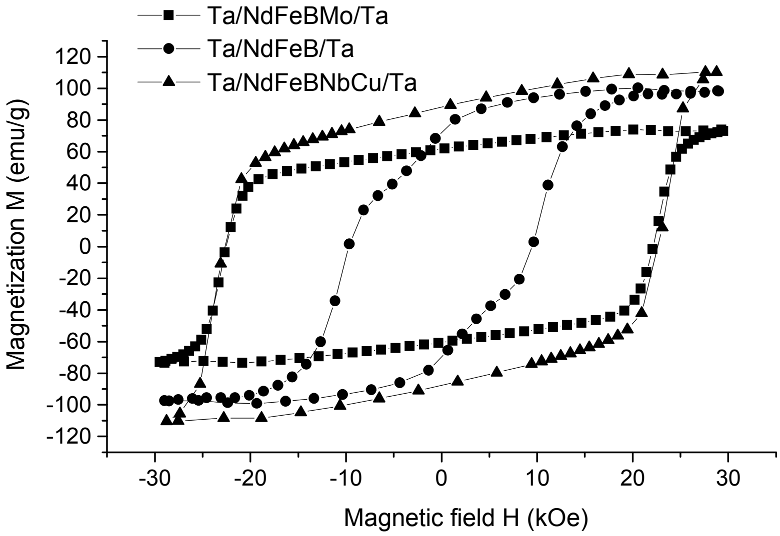
In recent years, nanocrystalline Nd-Fe-B thin film permanent magnets have been extensively studied as promising candidates for magnetic microdevices [1]. Using suitable additives, the grain sizes and the chemical composition of the grain boundaries can be tailored on the atomic scale leading to the desired magnetic properties. The addition of different refractory metals such as Nb and Mo in Nd-Fe-B alloys improves the hard magnetic properties and thermal stability. Thus, the addition of Nb acts in the sense of inhibiting the grain growth [2] and the addition of Mo decreases the crystallization temperature of the $Nd_2Fe_{14}B$ phase, increases the corrosion resistance and also suppresses the formation of the soft phases [3]. Moreover, the Mo addition leads to an almost rectangular demagnetization curve. Comparative results concerning the influence of the Nb and Mo additions on the structure, magnetic properties and thermal stability of Nd-Fe-B thin films have been investigated. The figure below presents the hysteresis loops for Ta/NdFeB/Ta, Ta/NdFeBMo(1at.%)/Ta and Ta/NdFeBNb(1.5at.%) Cu(0.5at.%)/Ta thin films, annealed for 20 minutes at 650°C.



The coercive field for Mo and NbCu -containing samples is larger than for the Nd-Fe-B samples due to the domain wall pinning effect within the intergranular region. As compared to Ta/NdFeB/Ta thin films, the losses in coercive field for Ta/NdFeBMo/Ta and Ta/NdFeBNbCu/Ta thin films are smaller with 21% and 18%, respectively, at 150°C.

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PRACTICAL ASPECTS OF MAGNETORESISTIVE SENSORS FABRICATION

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From an experimental point of view, producing a high quality magnetic tunnel junction sensor is a very complex task. We have fabricated MgO-barrier magnetic tunnel junctions with the following multilayer structure: Ta (30nm) / CoFe (2nm) / IrMn (15 nm) / CoFe (2nm) / Ru (0.8nm) / CoFeB (3nm) / MgO (1.6 nm) / CoFeB (3nm) / Ta (10nm) / Ru (5nm). Growth conditions are very important. The roughness and the structure of the interfaces play a crucial role in the electrical and magnetic properties of the MTJ structures. The MgO barrier layer should be extremely thin but continuous. A high roughness of the previous layer will influence the morphological properties of the MgO layer. Also, a high roughness of the Ru layer can influence the antiferromagnetic coupling provided by the SAF structure which is very important in order to individually switch the magnetization of CoFeB ferromagnetic electrodes. Atomic force microscopy has been used to characterize the surface smoothness of the layers. The MTJ structures require difficult patterning processes and annealing at high temperature that may also introduce a series of difficulties. Some of these problems and fabrication aspects are presented and discussed.

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TESTING THE MAGNETO-RESISTIVE SENSORS BY MEASURING THE SENSITIVITY AND NOISE AT LOW MAGNETIC FIELD

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In this paper we present a setup and methods for testing the magneto-resistive sensors at low magnetic field. The sensors involved in our tests are SpinTJ Series magnetic field sensors from Micro Magnetics which are based on Magnetic Tunnel Junction technology. These sensors are used in a number of cutting-edge industrial and research applications, including semiconductor failure analysis, compassing and navigation applications, bio-magnetic sensing, basic and applied research in magnetism [1]. By testing different configurations for the STJ300 TMR sensor we found some interesting results. The sensitivity of the sensor is affected by the bias current/voltage levels. Increasing the bias current the sensitivity and the resolution of the sensor decrease, the sensitivity and the resolution are inversely proportional to the bias level. We used two methods in order to estimate the noise and sensitivity: in one case we get the resolution by estimating the noise from PSD and in the second case we calculate the noise by statistics methods using the sensor in a bridge configuration (Wheatstone bridge) where the unbalance current determine variation of RTD (residence time difference). There are variations in sensitivity between the different bias configurations that lead us to the conclusion that the bias settings must be carefully chosen in order to achieve the highest sensitivity and resolution.

Acknowledgment
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STUDY OF THE INFLUENCE OF THE ELECTRODEPOSITION CONDITIONS ON THE NiFe THIN FILM CHARACTERISTICS

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The electrodeposited NiFe alloy thin films are widely studied because of the possibility to use them for data storage and magnetic sensors. This electrodeposition technique allows a better control of the film thickness, composition and of the stoichiometry of alloys. In this work we have studied the influence of the electrodeposition condition on the NiFe thin film characteristics. For performing the electrochemical deposition, we used a three-electrode cell. The substrates used in this work were Si samples. Prior to electrodeposition, an adhesion layer of Au film was coated onto the Si substrate by thermal evaporation in order to serve as working electrode during electrochemical deposition. All experiments were performed at room temperature by pulsed electrodeposition. The NiFe thin films were electrodeposited from an aqueous solution of $NiSO_4$, $FeSO_4$ and H_3BO_3 in different concentrations and with different additives. After electrodeposition, the surface morphology of the obtained samples were characterised by Scanning Electron Microscopy (SEM) using a JEOL microscope equipped with energy dispersive X-ray spectroscopy (EDS) analysis tool. The roughness and the thickness of the electrodeposited thin films was determined by Atomic Force Microscopy (AFM). The thinnest, good quality, NiFe continuos thin film obtained in this work is 15 nm in thickness. The synthesis of NiFe alloys thin films with a thickness smaller than 15 nm by electrochemical deposition lead to discontinuous thin films. The roughness of the NiFe thin films deposited from the electrochemical bath, without additives, is 2 nm. The presence of additives in the electrochemical bath decreases the roughness of the deposited thin films (0.7 nm for thin films deposited from a solution with polyethylene glycol – PEG and 0.6 nm for thin films deposited from the solution with saccharin) while the thickness of electrodeposited thin films increases.

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PREPARATION OF ALUMINA TEMPLATES WITH DIFFERENT PORE CONFIGURATION BY NANOINDENTATION WITH ION BEAM

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The preparation of alumina template by anodisation of pure aluminum in various acidic electrolytes has attracted considerable attention in recent years because a variety of nanostructures (metals and semiconductors, as well as multilayered) have been produced by electrochemical deposition within the nanopores of the anodic aluminum oxide (AAO). Anodic alumina oxide template possesses self-organized cylindrical pores, with high densities and controllable pore sizes.

In this work, we prepared anodic alumina templates with different pores configuration by nanoindentation with ion beam follow by anodisation. By nanoindentation, prior to the anodisation, on the aluminum surface we have designed initiation sites, with different configurations and different distances between two successive holes for ordered nanopore arrays by using an advanced lithographic technique – Focused Ion Beam (FIB). The anodisation process was performed at 40V, in oxalic acid 0.3M aqueous solution at 2°C and 15°C, respectively. The obtained membranes were characterized by Scanning Electron Microscopy (SEM) using a Zeiss microscope. The AAO images indicate that the nanopores follow the same arrangement like the initiations sites (Figure 1).

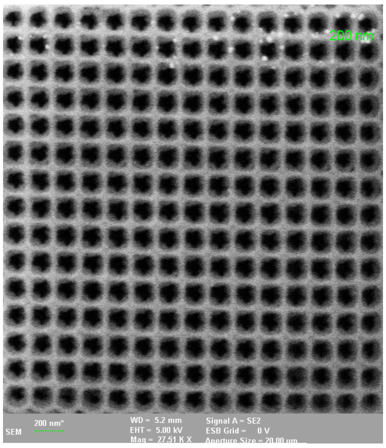

Fig. 1. Top view SEM micrographs of a highly ordered anodic alumina template with square nanopores array configuration

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ELECTROCHEMICAL DEPOSITION OF MULTILAYERED CoFeB/Sn NANOWIRES

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Ferromagnetic nanowire arrays present great interest due to their potential applications as high density magnetic recording media and magnetoresistive sensors [1,2]. Electrodeposition into nanoporous membranes is an efficient low-cost method for the fabrication of high quality multilayered nanowires.

In this paper we present some results on the preparation and characterization of electrochemically deposited [CoFeB/Sn] x n multilayered nanowires. Systematic studies have been carried out in order to obtain the softest magnetic materials, by varying the composition, the potential value and the t_{on}/t_{off} ratio of the pulsed deposition potential. The optimized conditions which yielded to the smallest in-plane coercivity, H_c = 9.9 Oe, for the electrodeposited thin films were used for the electrodeposition of the nanowires.

The nanowires were deposited in commercially available Whatman alumina membranes, with thicknesses of 60 µm. Sn constitutes a less expensive alternative for the use of nonmagnetic metals in the specific electrodeposition bath, due to its negative reduction potential and still sufficiently more positive than the one for Co and Fe in order not to co-deposit, and it was used in our study for the fabrication of multilayered nanowires.

SEM images show a very good uniformity of the nanowires inside the membrane. The thickness of the layers can be adjusted by the deposition time, multilayered nanowires of 50 µm in length being obtained, with sequences of CoFeB layers (100 nm, 70 nm, 50 nm) and Sn layers (30 nm, 20 nm, 10 nm). VSM measurements revealed in-plane coercivities up to 75 Oe, much larger than the ones obtained for the similar thin film structures. The reason for such a behavior is not fully understood, and it can be ascribed to the magnetostatic interactions between nanowires in the array. The orientation of the easy axis is determined by the competition between shape and magnetocrystalline anisotropies, as well as by the ferromagnetic and nonmagnetic layers aspect ratio (length/diameter) through dipolar interactions, revealing tunable magnetic properties for desirable applications.

Acknowledgment

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INFLUENCE OF ELECTRODEPOSITION CONDITIONS ON THE FABRICATION OF FeGa NANOWIRES

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Galfenol ($Fe_{80}Ga_{20}$) alloy is an important material due to its large magnetostriction and high ductility [1], but its electrodeposition has been proven to be challenging [2].
The aim of this work is to find the optimum conditions for FeGa nanowires preparation by electrodeposition. We used an electrochemical bath containing $FeSO_4$ and $Ga_2(FeSO_4)_3$ as ion metals sources and H_3BO_3 as buffer agent. The pH of the solution was kept below 2.5 in order to prevent the formation of GaOH, which makes it unstable [2]. The oxidation of Fe^{2+} to Fe^{3+} can be avoided by adding ascorbic acid or sodium citrate.
Thin films have been electrodeposited first. The pH of the electrodeposition bath plays a major role. At low pH the thin films present very poor quality or are not deposited at all, while at high values of the pH the solution become unstable.
Electrodeposition of nanowires inside Whatman membranes in the presence of sodium citrate was proven to be impossible for all pH values. The presence of sodium citrate causes the shift of the hydrogen evolution that accompanies the deposition of nanowires to lower overpotentials [1] and causes a local rise of the pH inside the pores, and its value exceeds the limiting one. We electrodeposites nanowires from baths containing ascorbic acid at a pH value of 1.8 and a potential of -1.8 V. At potentials more positive than -1.3 V the deposition is not possible, and more negative potentials damage the alumina membrane.
We concluded that the most important factors determining the uniformity of the nanowires are the pulse plating conditions and the presence of surfactants. The values of the t_{off} and t_{on} in the plating mode determine the packing density of the nanowires inside the membrane, which is an important factor when measuring the magnetic properties of the nanowires embedded in the membrane and have to take into account the interaction between them.

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MAGNETIC STRUCTURE AND TRANSPORT PHENOMENA IN Pb LOW DOPED $LaMnO_3$ MANGANITES

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The doping of alkali-earth cations (as Ba, Sr, Pb) at the A site of colossal magnetoresistive (CMR) manganites (ABO_3) is an interesting topic of study. Substitution with cations with a different radius as those of La^{3+} lead to an increase of the chemical disorder degree and a diminish of the Curie temperature, implicitly to a decrease of the metal-insulator transition temperature. Small change in the Mn^{3+}–O–Mn^{4+} bond environment leads also to important changes of the electronic phases concentrations and its characteristics. The $La_{1-x}Pb_xMnO_3$ manganites were synthesized by sol-gel method at Chemistry Faculty, "Al.I.Cuza" University, Iasi, Romania.

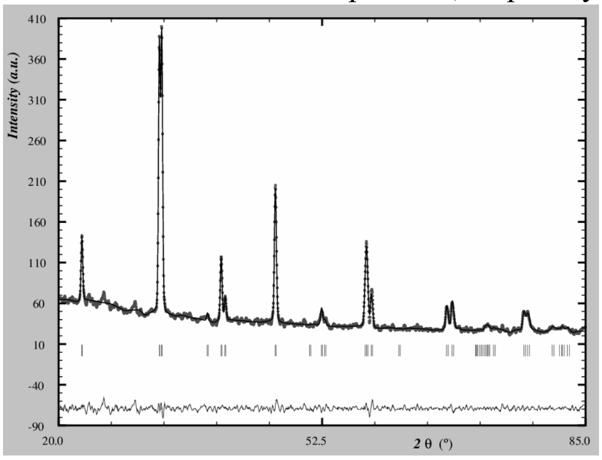

Fig. 1. Diffractograms of $La_{0.97}Pb_{0.03}MnO_3$: bottom-Bragg position of calculated maxima (vertical segment) and the difference between observed and calculated diffractograms, by using FullProf code.

The samples were treated at lower temperature, in a closed PbO atmosphere, to prevent Pb evaporation from the samples (JINR – Dubna). Our aim was to establish the influence of La substitution with Pb on magnetic/crystalline structure and transport properties. XRD and optical microscopy were performed to proof the phase composition and microstructural parammeters (lattice constants, cations and anions positions, average size of crystalline blocks, microstrains: all parammeters were determined at room temperature). Variation of molecular magnetization with temperature and magnetic filed intensities were determined with a Foner type magnetometer between 77 and 500 K at NIRDTP, Iasi, Romania. Resistance measurements with temperature and magnetic field intensities were performed by using a closed cycle refrigerator and an electromagnet at JINR-Dubna, Russia. The synthesized manganites contain only the perovskite phase (GS R -3 c). We observed a small variation of the lattice constants, despite the difference between the radii of La^{3+} (1.216 Å) and Pb^{2+} (1.35 Å). On other hand, the molar magnetization is close to 3.7 μ_B/f.u., near to maximum theoretical value for molar magnetization, while the Curie temperature is about 250 K for all investigated samples. A minimum of the Curie temperature was observed, for x=0.10, and a maximum of the molar magnetization, for x=0.06. Transport properties, determined between 7 and 350 K, indicated a metallic behaviour for the samples with $x \leq 0.10$. The transition temperature between metallic and insulator behaviour decreases with increase of Pb concentration in the samples. An analysis of transport phenomena, due to the electron-electron, electron-magnon interactions, which dominate at low temperature (7 - 60 K), was performed.

Co INFLUENCE ON THE LOW TEMPERATURE TRANSPORT PHENOMENA IN $La_{0.54}(Nd/Ho)_{0.11}Sr_{0.35}Mn_{1-x}Co_xO_3$ MANGANITES

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Some manganites have two very interesting effects: colossal magnetoresistance (CMR) and giant magnetostriction (MS) observed in them near the Curie point. CMR materials can be used as highly sensitive and electrically readable magnetic-field sensors for the read-head of the magnetic memory and compounds with large MS in devices, which convert electrical energy to mechanical energy. $La_{1-x}Sr_xMnO_3$ with $x\approx0.3$ is known as having a metallic behavior until about 370 K and a large magnetoresistance. Manganites as $Nd_{1-x}Sr_xMnO_3$ (x=0.33 or 0.45) behave as metals until 250 K, but exhibit a large magnetostriction around transition temperature. On other side it is known that cobalt cations can jump from a low to a high spin state at 90 K ($LaCoO_3$), due to a small difference between the spin states energy. An intermediate spin state of Co is present at high temperature. Our aim is to establish the influence of substitution of La with Nd or Ho and, in the same time, of Mn with Co.

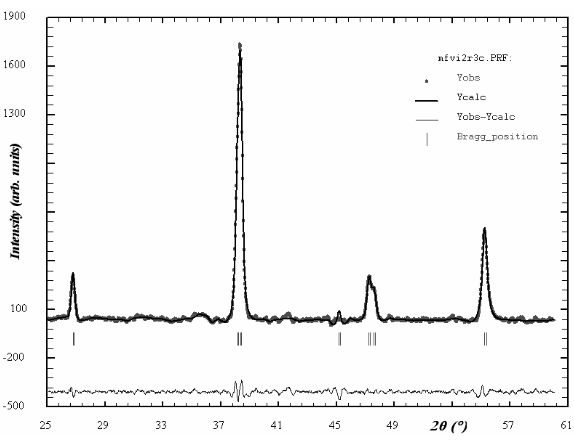

Fig. 1. Diffractograms of $La_{0.54}Nd_{0.11}Sr_{0.35}Mn_{0.95}Co_{0.05}O_5$: bottom-Bragg position of calculated maxima (vertical segment) and the difference between observed and calculated diffractograms, by using FullProf code.

The substitution of La^{3+} (1.216 Å) with Nd^{3+} (1.163 Å) or Ho^{3+} (1.072 Å) should lead to a decrease of the Curie/transition temperatures, in agreement with the literature. The substitution of Mn with Co should increase the magnetoresistance at high temperature. The $La_{0.54}(Nd/Ho)_{0.11}Sr_{0.35}Mn_{1-x}Co_xO_3$ manganites were synthesized by sol-gel method at Chemistry Faculty, "Al.I.Cuza" University, Iasi, Romania. XRD and optical microscopy were performed to proof the phase composition and microstructural parammeters (lattice constants, cations and anions positions, average size of crystalline blocks, microstrains: all parammeters were determined at room temperature), indicationg the presence of only rhombohedral phase (GS R-3c). Magnetic and transport characteristics were determined in the same way as in the work [1]. A small maximum was observed for lattice constants, when the Mn is substituted by Co. The molar magnetization for the La substituted with Nd manganites have a maximum with Co concentration, suggesting a contribution of Co to the magnetization of the samples. Curie temperature follows the same variation. Molar magnetization and Curie temperature attain the smallest values for maximum Co concentration.

P.32

SIMULATION OF PERCOLATION PROCESS IN CERAMIC COMPOSITES

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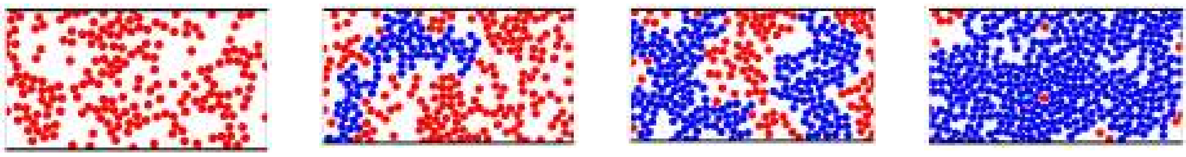
The percolation theory of composites is used to describe the role of interconnectivity between a conductive and an insulating phase in composite ceramics in driving the electrical switching between the insulator to the conductive state [1, 2]. The percolation threshold indicates the minimum volume filling fraction of the conductive particles included into a dielectric matrix that forms a continuous pathway.

In searching for new di-phase composites formed by an insulating ferroelectric phase and a more conductive one (*e.g.* ferrite), it is highly important to determine the role of the composition and microstructural factors (*e.g.* grain size and shape, interconnectivity degree) on the percolation limit [3]. In addition, recent combinations of ferroelectric ceramics with metallic inclusions or carbon nanotubes are highly important as giant permittivity materials for energy storage applications [4].

Our study proposes a Monte – Carlo simulation of the percolation process in a di-phase conductive-insulating system. For different filling fractions, it is shown that conductive channels are generated inside the composite structure. The simulations show that there is a percolation process probability, *i.e.* even for the same filling factor, the composite percolates or does not percolate, depending of the arrangement way of the conductive particles in the ferroelectric matrix.



(a) f = 0.25 *(b) f = 0.4* *(c) f = 0.55* *(d) f = 0.7*

Figure 1. State of the composite material formed by conductive inclusions (red) into the ferroelectric matrix (blue) for different filling factors: (a) insulator state: the conductive particles are isolated, (b) a percolation pathway formed by conductive particles in contact, (c) two conductive clusters, (d) a single conductive cluster including almost all the conductive particles.

Acknowledgement

The financial support from the Grant POSDRU/89/1.5/S/ 63663 is highly acknowledged.

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EFFECTIVE MEDIUM APPROXIMATION MODELS FOR SOME DI-PHASE COMPOSITE

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Effective Medium Approximations (EMA) models are developed to predict the dielectric parameters of a macroscopic material that are usually completely different from the properties of the parent phases, as a result of the interphase coupling, shape and composition, interfaces and interface- driven phenomena [1, 2]. The most common approximations are Maxwell – Garnett formula, that correspond to small filling concentration of isolated spherical inclusions embedded into continuous matrix and Bruggeman formula, that offer good approximations for all filling concentrations and consider the properties of matrix or host the same as the effective field medium itself [3].

Our paper models dielectric and magnetic properties of some di-phase composites material using effective field models. We take into consideration a multiferroic material that exhibit simultaneously magnetic and ferroelectric order and a coupling between them - $CoFe_2O_4$–$Pb(ZrTi)O_3$. The composites were prepared by citrate–nitrate combustion technique by using $Pb(Zr,Ti)O_3$ pure and Niobium doped template powders obtained by the mixed oxide method [4].

Taking into consideration the dielectric and magnetic properties of the phases, the volume fraction inclusions, geometrical shapes and arrangements, we investigate the dielectric and magnetic properties of the composites as a sum of the phases. Effective Medium Approximations models give just a rough approximation of the composite property. The obtained differences and the usefulness of a model for this composite microstructure are discussed in the paper.

Acknowledgement

The financial support from the Grant POSDRU/89/1.5/S/ 63663 is highly acknowledged.

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MONTE CARLO SIMULATIONS FOR DESCRIBING THE FERROELECTRIC-RELAXOR CROSSOVER AND LOCAL POLARISATION IN $BaTiO_3$-BASED SOLID SOLUTIONS

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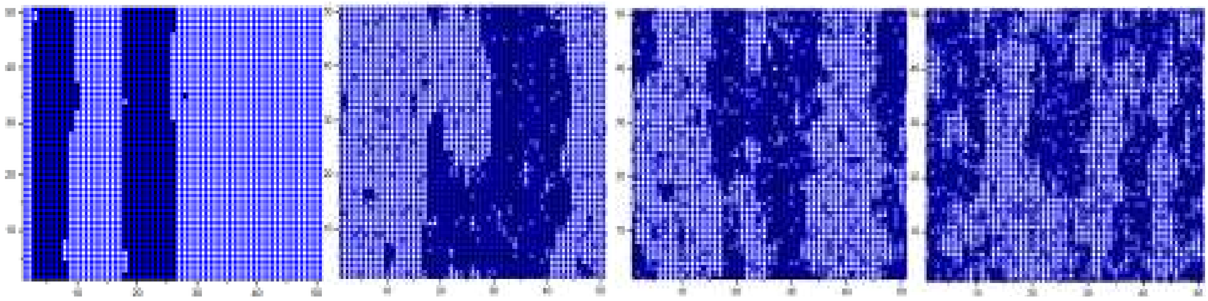
The properties induced by the homovalent addition M^{4+} (M=Zr, Sn, Hf) in $BaM_xTi_{1-x}O_3$ solid solutions were described on the basis of a Monte Carlo model, in which non-ferroelectric $BaMO_3$ randomly distributed unit cells were considered. The P(T) dependence shows a continuous reduction of P_r and T_C and a modification from a first-order to a second-order phase transition, when increasing the M^{4+} concentration. The system's tendency to reduce the polar clusters size while increasing their stability above the Curie range by increasing the substitution (x) is also described. The equilibrium micropolar states during the polarization reversal process while describing the P(E) loops were comparatively monitored for the ferroelectric (x=0) and relaxor (x=0.2) states. Polarization reversal in relaxor compositions proceeds by the growth of several nucleated domains („labyrinthine domain pattern") instead of large scale domain formation typical for ferroelectric state. The spatial and temporal evolution of the polar clusters in $BaM_xTi_{1-x}O_3$ solid solutions at various x was also described by the correlation length and correlation time. As expected for the ferroelectric-relaxor crossover characterized by a progressive increasing degree of disorder, local fluctuations cause a reducing correlation time when the substitution degree increases, at a given temperature. The correlation time around the Curie temperature increases, as reflecting the increasing stability in time of some polar nano-regions in relaxors by comparison with ferroelectrics.



(a) x=0.0 (b) x=0.1 (c) x=0.2 (d) x=0.3

Fig. 1 As-grown domain structures showing the cluster decreasing size with increasing the degree of substitution (white: upwards polarization, black: downwards polarization, gray: zero dipole moment).

Acknowledgements

This work was supported by CNCSIS-UEFISCSU-PNII-RU-TE code 187/2010 grant.

DIELECTRIC AND NONLINEAR PROPERTIES OF La-DOPED $BaTiO_3$ CERAMICS

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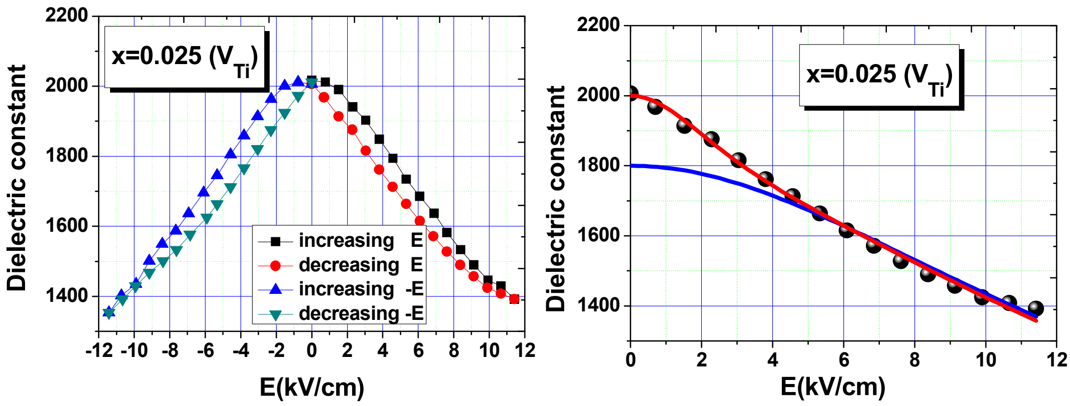
The interest in searching the tunability properties in various types of $BaTiO_3$-based ceramics observed in the last few years is related to the continuous growth of their use as tunable microwave devices, variable capacitors, phase shifters, tunable filters and voltage-controlled oscillators for wireless communications industry. The electric field-induced tunability describes the ability of a material to change its permittivity under the electric field. While it is known that tunability is affected by composition and microstructures, the role of other parameters like charged defects is far less investigated.
In the present work, the dielectric behaviour and the non-linear characteristics of La-doped $BaTiO_3$ solid solutions prepared by the solid state reaction method was investigated. Ceramic samples with lower dopant content ($0 \leq x \leq 0.005$) corresponding to the $Ba_{1-x}La_xTiO_3$ formula, as well as specimens with higher lanthanum concentrations with compositions described by $Ba_{1-x}La_xTi_{1-x/4}O_3$ ($0.005 \leq x \leq 0.05$) formula were produced by sintering at 1300°C / 6 hours. The temperature dependence of dielectric permittivity of the ceramics has been investigated. The results show a decrease of T_C with lanthanum addition. The degree of diffuseness of phase transition is more pronounced for high La content, implying the existence of a composition-induced phase transition of the ceramics. The dc-tunability at room temperature was investigated and experimental data were discussed in terms of the Johnson model completed with a Langevin term that describes "extrinsic" contribution to the nonlinear ε(E) dependences (Fig.1).



(a) (b)

Fig.1 (a) Dc-tunability data for La-BT ceramics with Ti vacancies to a complete field-cycle; (b) Fit of experimental data with multipolar model

DIELECTRIC AND TUNABILITY PROPERTIES OF FERROELECTRIC-RELAXOR $BaTi_{1-X}Sn_XO_3$ SOLID SOLUTIONS

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Ceramic samples of $BaSn_xTi_{1-x}O_3$ with compositions x = 0; 0.05; 0.10; 0.15 and 0.20 were prepared by solid state reaction and densified by sintering at 1400^0C for 4 h. A pure perovskite phase, with a high density and a high degree of homogeneity was obtained for all the investigated compositions. As the Sn content (x) increases, the tetragonal distortion c/a decreases and the symmetry changes from tetragonal (specific for pure $BaTiO_3$) to cubic. Therefore, a ferroelectric-relaxor crossover is induced when increasing the Sn concentration.
Dielectric constant of $BaTi_{1-x}Sn_xO_3$ is strongly field-dependent: relative tenability between 0.18 – 0.85 was found for all the compositions at the applied field of E = 12 kV/cm (Fig. 2). The involved mechanisms in the tenability properties are discussed. The dielectric and ferroelectric properties of the $BaSn_xTi_{1-x}O_3$ ceramics are strongly dependent on the Sn addition, grain size and on temperature.

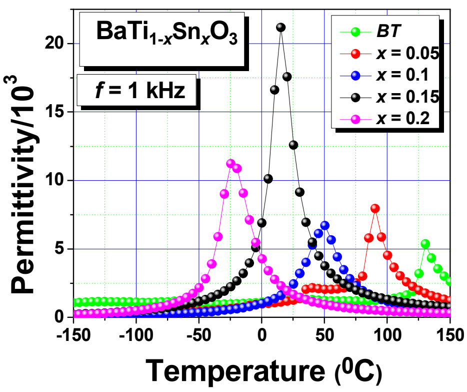

Fig. 1 Permittivity vs. temperature

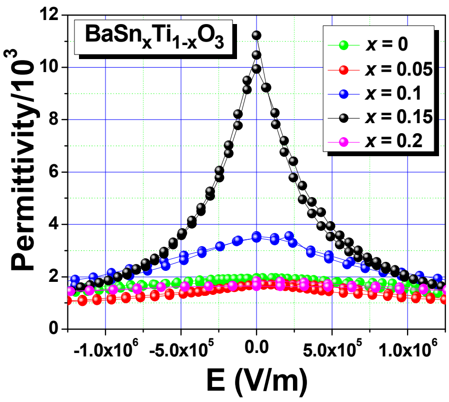

Fig. 2 Permittivity vs. the applied field.

Acknowledgments
Financial support from Grant POSDRU/88/1.5/S/47646 (ESF Romania) is highly acknowledged.

IMPEDANCE SPECTROSCOPY AND MAGNETIC INVESTIGATIONS OF $BiFeO_3$ CERAMICS PREPARED BY ONE-STEP SINTERING METHOD

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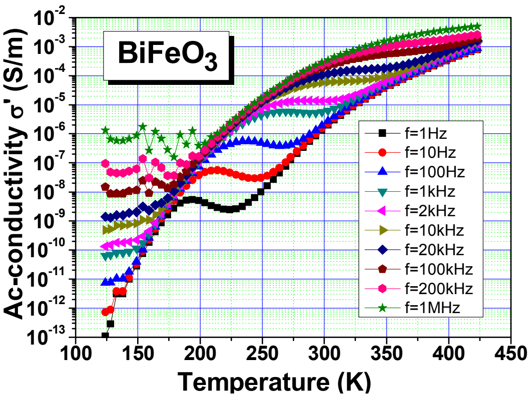
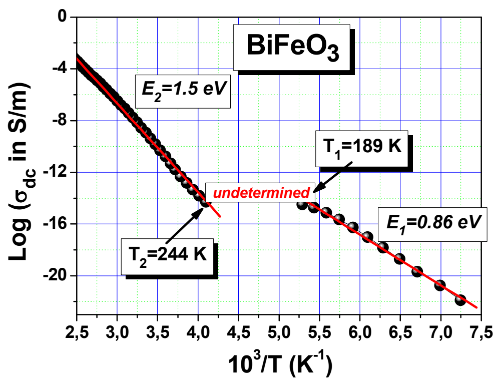
In this paper, the electrical properties of pure $BiFeO_3$ ceramics prepared by a single-step solid-state sintering method were investigated. The unique phase detected was the rhombohedral $BiFeO_3$. The single-step solid state sintering method results in a non-homogeneous microstructure, consisting of ceramic grains with irregular morphology. A very interesting feature is observed on the conductivity in the low-frequency range (dc-conductivity). The ac-conductivity vs. temperature presented in the Fig. 1(a) shows that, except the low-temperature range, all the values of conductivity at any frequencies lay between the two "master-curves" corresponding to the lowest and highest frequency, respectively, giving rise to the much higher extreme activation energies. The Arrhenius plot of the dc-conductivity determined at the lowest frequency *vs.* 1/T (Fig. 1(b)) shows two distinct linear regions separated by the mentioned temperature range of (189 – 244) K, for which the dc conductivity could not be determined from the present impedance spectroscopy data only. It is clear, out of any doubt that in the mentioned temperature range, a conduction anomaly takes place. Further detailed studies to confirm the presence of such anomaly in ceramics prepared by various routes in order to understand the origin of this conductivity anomaly are under way.



(a)



(b)

Fig.1. (a) Temperature dependence of the dc-conductivity for the $BiFeO_3$ ceramic at a few selected frequencies. (b) Frequency-dependence at a few selected temperatures in the range of (124 – 425) K of the Arrhenius plot of the dc-conductivity.

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STRUCTURAL INVESTIGATION AND FUNCTIONAL PROPERTIES OF $Mg_xNi_{1-x}Fe_2O_4$ FERRITE

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MFe_2O_4 ferrospinels constitute a very important group of magnetic materials as they have a wide range of applications in devices used in telecommunications systems, computer memories, transmitting microwaves, heat transfer, etc. Among different ferrites, magnesium ferrite $MgFe_2O_4$ enjoys a special attention because of its vast applications in high-density recording media, heterogeneous catalysis, adsorption, sensors and magnetic technologies. Nanoparticles of $MgFe_2O_4$ have good photoelectrical properties. Nickel ferrites $NiFe_2O_4$ are one of the most important ferrites with reversed spinel structure having ferrimagnetic properties. This material is largely used in electric and electronic devices and in catalysis.
The structural and electrical properties of magnesium-substituted nickel ferrite having the general formula $Ni_{1-x}Mg_xFe_2O_4$ (x=0; 0.17; 0.34; 0.5; 0.64; 0.83; 1) has been studied as a function of magnesium ion concentration.
The $Ni_{1-x}Mg_xFe_2O_4$ (x=0; 0.17; 0.34; 0.5; 0.64; 0.83; 1) ferrite powders were prepared using the combustion reaction by using as cations source nitrates: $Ni(NO_3)_26H_2O$, $Fe(NO_3)_39H_2O$ and $Mg(NO_3)_26H_2O$, and as combustion agent was used the citric acid $C_6H_8O_7$.
The FTIR spectra for the $Ni_{1-x}Mg_xFe_2O_4$ (x=0; 0.17; 0.34; 0.5; 0.64; 0.83; 1) system were recorded in the range 400-1000 cm^{-1}. The spectra show two absorption bands ν_1 and ν_2 corresponding to the stretching vibration of the tetrahedral and octahedral sites around 600 and 400 cm^{-1}, respectively.
The powder X-ray diffraction pattern confirms the spinel structure for the synthesized compound. The calculated lattice constant (a) values of $NiFe_2O_4$ (x=0) and $MgFe_2O_4$(x=1) are 8.326 and 8.379Å, respectively, which agree with the reported values and the X-ray density decreases with increase in Mg^{2+} ion content.
Study of the electrical and dielectric properties give valuable information about the behaviour of electric charge carriers which leads to good understanding and explanation of conduction mechanism in ferrite. The dielectric properties have been investigated as a function of frequency at room temperature and were interpreted in terms of Maxwell-Wagner phenomena and conductivity mechanism. The magnetic properties show that saturation has a decreased trend with increased Mg content combined with a constant coercitiv field.

COMPUTATIONAL MICROMAGNETICS AT NANOSCALE USING A PARALLEL COMPUTING SYSTEM

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In most cases an efficiently and quickly obtaining of a new magnetic material is currently focused on the study of micro and nano materials properties. The developement of such new nano and micro magnetic materials used in various applications is strongly related to the ability to make accurate predictions of their magnetic properties. Nanometer-sized magnetic 'objects' are theoreticaly placed at the limit between classical and quantum magnetism so, detecting their magnetic properties is technologically very challenging and from the computational point of view a very difficult task. Thus, we experimentally implemented a parallel computing system working with some academic software packages [1] that were adapted to our current modelling problems. Accumulation based on logistics and scientific development in recent years allowed the emergence of some modern computational strategies in our laboratory. Based on concurrent programming languages, libraries and parallel programming models created to run on parallel computers we early implemented a parallel computational system on nanomagnetics magnetic properties computation which use a finite element method.

The simulation of a fully integrated magnetic systems that take into account most of the magnetic interactions of a magnetic nanowire for example, easily leads to large scale simulation involving millions of degrees of freedom. In order to perform the simulation on the built parallel computers system the current algorithms were adapted to achieve scalability. We exploited three dual-core computers with Message Passing Interface (MPI) which is the most widely used message-passing system. Were followed as usual the testing and validation of the method, the speedup obtained for the micromagnetic simulation as compared to the original micromagnetic solver.

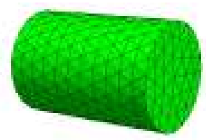

Fig. 1. Cylinder shape and finite element mesh of a 30 nm length and 10 nm radius nanomagnetic object.

As a continuation of our past work [4] the computational experiments were carried on generic nano-wires magnetic materials for example, see **fig. 1** and generic nanomagnetic films. Numerical micromagnetics helped us to understand the influence of the granular structure of the wire on the magnetic properties, offers a frame for the domain walls manipulation by using geometric constraints on the nanoscale, make possible the histeresis loop theoretical evaluation and more.

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USING ACCELERATION NANOSENSORS FOR COMPUTER CONTROLLED ULTRASONIC BASED PROCESS

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Micro-electromechanical systems (MEMS), nanosensors, nanoactuators are essential components of the fastest evolving technologies. The recent research has allowed the design and manufacture of the micro-machine structures used as sensors for physical quantities. The first part of this paper exposes a review of the Principia of the sensor material and fabrication technology. The mainly used MEMS materials are highlighted. A particular application of the Freescale's MEMS-based acceleration sensors is presented in the second part of the paper. The motion control wide used in the recent automotive electronics, computer peripherals, cell phones and PDAs is mainly based on acceleration nanosensors. These devices are also low frequency ultrasound sensitive. This fact makes them usable in the control operation of the ultrasonic based treatment processes. The paper presents an application extension of the acceleration nanosensors for the ultrasound generators active control. The particular signals processing techniques for nanosensors placed in real environments where the ultrasounds propagate (air, water, solids) as well as the response characteristics of the nanosensors due to their interaction with the ultrasonic field are highlighted.

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TEMPERATURE SENSOR BASED ON LOW CURIE TEMPERATURE MAGNETIC MATERIALS

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Low Curie temperature magnetic materials are good candidates for designing sensitive magnetic temperature sensors by changing the Curie temperature (T_c) of the magnetic material in a controlled manner. In this work we propose magnetic temperature sensors of low dimensions, working in relatively narrow temperature ranges, close to human body temperature, which uses a glassy FeNbB alloy with chromium additions as a magnetic core. Chromium has been used in the past to lower the Curie temperature of the FINEMET nanocrystalline soft magnets by refining the nanograins [1].The sensors are constructed using two different techniques: (i) with voltage output and (ii) with frequency output. The first one (i) is constructed by winding of 150 turns of enamelled copper wire of 0.07 mm diameter on a glass tube with elliptical section, in which the magnetic core (FeCrNbB magnetic ribbon) was introduced. To be used as a temperature sensor this small coil was inserted in a Colpitts oscillator using an operational amplifier. For the output signal to be rectangular, a pulse generator was set-up using an operational amplifier in comparator configuration (fig. 1). The change in the temperature of the magnetic core induces a very high change rate in the magnetic permeability, hence changes in the coil's inductance and consequently in the output frequency. The second one (ii) consists of an excitation coil and a pick-up coil constructed by winding two copper enamelled wires on the glass tube, in which the magnetic material is inserted. The voltage output signal of the pick-up coil is amplified and visualized using a digital oscilloscope. The change in the magnetic core temperature induces a change in the core's permeability and hence in the output voltage in the pick-up coil.

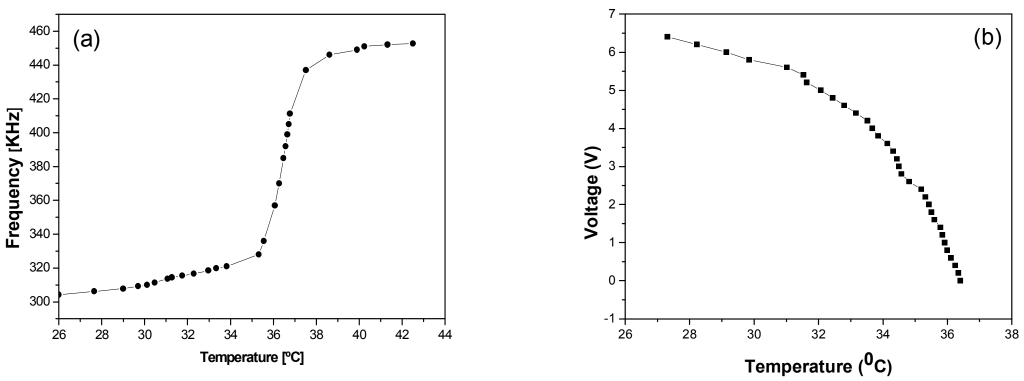

Fig. 1: Output frequency vs. temperature (a) and output voltage vs. temperature (b) characteristics of the temperature sensors.

Using these configuration, temperature sensors or of small dimensions (down to 2 mm), high sensitivity (0.1–0.025), and good repeatability can be constructed. The measured temperature range may be shifted to lower of higher values by varying the Cr concentration in the FeNbB alloy. The proposed sensor can be also used as thermostat for various applications or on-off switches type relays.

Acknowledgment

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MAGNETIC AND STRUCTURAL PROPERTIES OF α-Fe_2O_3 THIN FILMS

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The main interest behind this article was the investigation of magnetic and structural properties of thin-film hematite. A thin film of 150 nm was grown on a ceramic substrate by the use of a spin-coating method.
The structure of the sample was studied by means of grazing angle X-ray diffraction (GAXRD, α=0.5°, Cu K_α radiation) which showed that the sample was indeed hematite (with space group 167 or R-3c).
The magnetic properties were studied as a function of temperature (5K – 300K) using a Vibrating Sample Magnetometer (VSM). The weak ferrimagnetic character of the hematite sample was observed. Fig. 1 shows the temperature dependence of the magnetization during Zero Field Cooling (ZFC) and Field Cooling (FC) measurements, under an applied field of 0.1T. A blocking temperature around 15K can be observed.

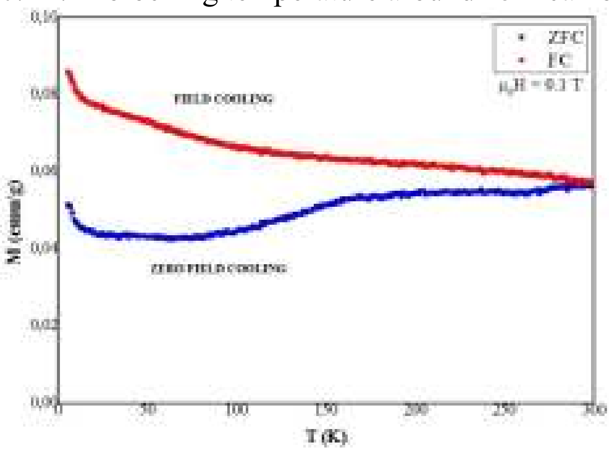

Fig. 1. Zero-Field-Cooling and Field-Cooling curves.

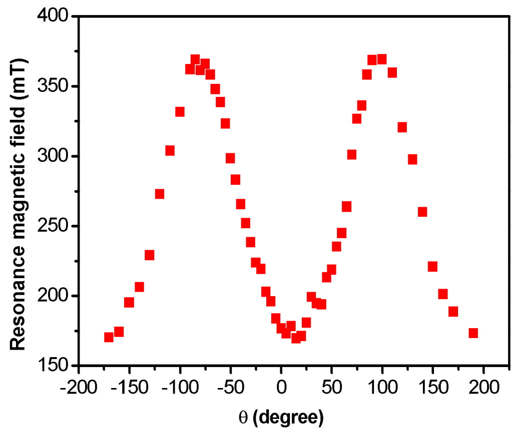

Fig. 2. Angular dependence of resonance fields.

Furthermore, Electron Spin Resonance (ESR) was performed on the hematite film, showing the resonance field as a function of the angle between the normal to the film plane and the magnetic field (Figure 2). The g-factor varied throughout the experiment from 1.84 up to 3.95. The data collected from the full angular dependence was compared to the Landau-Lifshitz equation, obtaining information regarding the anisotropy constants, the effective magnetization, as well as the orientation of the easy-magnetization axis [2].

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