Anexa 2a

Titlu proiect: *Straturi subtiri si nanostructuri pentru aplicatii medicale si spintronice. Obtinere si caracteerizare*
Categoria de proiect: 04-4-1121-2015/2017 IUCN-DUBNA
Contractul de finanţare: Ordinul IUCN nr.34 din 23.01.2015, tema 68
Manager proiect: IACOMI FELICIA

Lista rezultate

Nr. crt.	NUME AUTORI	TITLUL ARTICOLULUI/ CĂRŢII / COMUNICĂRII ŞTIINŢIFICE	REVISTA / VOLUMUL/EDITURA IN CARE A APARUT / CONFERINTA LA CARE S-A COMUNICAT	ANUL PUBLICARII/ COMUNICARII
		ARTICOLE ISI		
1	N. Iftimie, S. Tascu, I. Salaoru, R. Steigman, A. Savin, M. Irimia, F. Iacomi	The evanescent waves in metallic strip gratings and complex structures in subwavelength regime	Materials Today: Proceedings Volume 2, Issue 6, 2015, Pages 3846–3852, The Selected Papers of 10th International Conference on Physics of Advanced Materials, ICPAM-10	2015
2	G. Calin, R. Trusca, E. Vasile, V. Burlui, F. Iacomi	Synthesis and structural characterization of metallic nanostructures in AAO membranes	Journal of Optoelectronics and Advanced Materials (in press)	2015
3	G.G. Nedelcu, A. Nastro, L. Filippelli, M. Cazacu, C. Oliviero Rossi, A. Popa, D. Toloman, F. Iacomi	Synthesis and structural characterization of copolymer embedded magnetite particles	Applied Surface Science 352 (2015) 109-116	2015
4	P. Pascariu, A. Airinei, M. Grigoras, L. Vacareanu, F. Iacomi	Metal–polymer nanocomposites based on Ni nanoparticles and polythiophene obtained by electrochemical method	352 (2015) 95-102.	2015
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Statement

Thin films and nanostructures are an integral part of modern technology. The project was focused on design, elaboration and characterization of oxide functional thin films and metallic nanostructures, friendly environmental, for sensors/biosensors devices and for medical applications. The project theme belongs to Physics domain and to the priority European and international research domain which refers to nanotechnology, materials and advanced manufacturing. The target of the project was to establish and optimize the optical, electrical and magnetic properties of some functional and multifunctional magnetic and diluted metallic nanostructures and thin films, capable to increase the efficiency of above mentioned devices. It was established that by doping with transitional elements and rare earth elements the material functionality can be tuned. The project takes into account low cost synthesis methods together with advanced high precision ones and investigates the influence of synthesis conditions and doping in order to tune and optimize the structures and thin films functionality.

Taking into consideration the experience of the two groups from UAIC and IUCN, in the field of synthesis and characterization of nanostructures and thin films, in the structural, optical, electrical and magnetic and sensing characterization, the main activities proposed in this project contributed to the development of new advanced devices with increased functionalities. The results obtained enabled to establish the influence of synthesis conditions and chemical composition on the magnetic and sensing properties of thin films and metallic nanostructures.

The IUCN research group brought an important contribution to the characterization of high quality metallic nanostructures and thin films with special magnetic properties. UAIC research group contributed with low costs nanostructures, thin films and nanostructures with desirable quality and structural, magnetic and sensing investigations. Both teams developed systematic experimental and theoretical studies with an important impact in the field of sensor/biosensors and medical devices.

Neutron diffraction enabled to investigate the properties of ferromagneting materials, including the magnetic coherence length and Néel (ordering) temperature. While much research has been dedicated to the analysis of bulk ferromagnets, wide-angle neutron diffraction has been used to characterize ferromagnetic films with thicknesses on the order of 30–500 nm.

General objectives:

The general objectives consisting in developing of new materials with desired properties, including substrates, oxide matrixes, metallic nanostructures, semiconductor nanostructures and thin films proper for development of functional thin films and nanostructures for advanced devices, were all accomplished.

Specific objectives:

The fallowing specific activities were developed:

1) The designing and obtaining of thin films, semiconductor and metallic nanostructures with desired properties, for use in magnetic, magnetoresistive and sensors/biosensors and medical devices; 2) physical characterization of the synthesized materials by XPS, HRTEM, BET, XRD, ND, EPR and VSM 3) The designing a spin valve for possible applications in spintronics and sensors.

Activities:

UAIC and JINR teams developed the following activities:

- Deposition of thin films and synthesis of metallic nanostructures for sensors/biosensors/medical device applications - responsible: F.Iacomi UAIC Iasi;
- Deposition of thin solid films for sensors/biosensors/medical devices applications by spin-coating method-responsable: M.-L.Craus, JINR Dubna;
- Obtaining of magnetoresistive nanostructures by hydrothermal method-responsable: M.-L.Craus, JINR Dubna;
- Development of metallic and oxide nanostructures for possible applications as sensor and medical devices using sol-gel methods – responsible: F. Iacomi, M.-L. Craus
- Development of functional thin films (metals, metal oxides and manganites) for applications in sensor/biosensors/medical/spintronic devices by pulsed laser deposition, vacuum thermal evaporation, rf sputterin and spin coating methods - responsible: F. Iacomi, M.-L. Craus
- Structural characterization of porous matrices and patterned substrates (XRD, SEM, HRTEM, XPS, neutron diffraction) – responsible: F. Iacomi, M.-L. Craus;
- Processing of obtained results for publication- responsible F. Iacomi, M.-L. Craus

Results

<u>Synthesis of Co and Ni nanostructures in anodized aluminium oxide templates</u>

Metallic nanostructures have attracted the interest of researchers due to their fundamental importance and potential applications in nanodevices, sensors and catalysts. AAO/metallic (AAO - anodized aluminum oxide membrane) was obtained by using a sol-gel method that uses ultrasonic vibrations to induce the penetration of a coloidal solution through the pores of an anodized aluminum oxide (AAO) template. The AAO template, with the sol into its pores, was annealed at 648 K. The entire 'dip–anneal–dip' process was repeated three times. Finally, the metal nanostructures were formed by further annealing at 873 K in hydrogen atmosphere for 1 h.

Preparation of magnetic nanopowders

Magnetic nanoparticles were prepared by co-precipitation of the ferrous chloride ($FeCl_2.4H_2O$) and the ferric chloride ($FeCl_3.6H_2O$) solutions, choosing a molar ratio of Fe^{2+}:Fe^{3+} = 1:2 and using an alkaline sodium hydroxide (NaOH) solution [37]. Our reaction equipment consisted of a flat bottom flask and an overhead stirrer. In a reactor containing 160 ml distilled water at 80 C were added through vigorous agitation (stirring rate was 1000 rot/min) aqueous solutions containing Fe^{2+} and Fe^{3+} salts (120 ml aqueous solution, total 1.25 molar) and NaOH (and 120 ml of 5 molar). The black precipitate was formed at the early phase, but the medium was continuously stirred for 2 h at pH=12, maintaining the stirring rate, the temperature and adding slowly 10 ml 25% (w/w) tetramethylammonium hydroxide (TMAOH) to stabilize the MPs. No inert atmosphere or deaerated aqueous solutions were used in order to induce the formation of a single iron oxide magnetite phase.

Ag/ZnO/SiO2/Si architecture for possible bio-detection applications

The $Ag/ZnO/SiO_2/Si$ structure was fabricated by vacuum thermal evaporation technique and Scanning Electron Microscopy was used to evidence its high quality structure with parallel silver strips of same width and thickness. Simulation of the evanescent wave formation at the edge of Ag strips, with thicknesses in the range of micrometers, was performed, before performing the test in the subwavelength regime by the mean of a new transducer improved with metamaterials lens. The generation in slits, in air, of the electric evanescent mode, when metallic strip grating was excited with a TE_z polarized wave at a frequency of 474 Hz, was successfully demonstrated.

Manufacturing of a spin valve for spintronic applications

A ferromagnetic layer, LSMO ($La_{0.875}Sr_{0.125}MnO_3$), was deposited on LSAT ($La_{0.7}Sr_{0.3}Al_{0.65}Ta_{0.35}O_3$) substrate using a pulsed laser deposition (PLD) setup (SURFACE-TEC Gmbh). After PLD deposition, the sample was transferred into the evaporation chamber, where the spacer layer Alq_3, top ferromagnetic electrode Co, and aluminium (Al) contact layer were vacuum thermally evaporated, using different shadow masks for each layer.

Structural and magnetic investigations

The morphology and structure of AAO/metallic and magnetite nanostructures were investigated by using SEM, HRTEM, EPR and VSM methods.

X-ray diffraction (XRD) and neutron diffraction (ND) patterns of samples were obtained with a DRON 4 diffractometer and HFRD diffractometer (JINR Dubna-Russia). A systematic investigation of the structural and magnetic properties of the metallic nanostructures were done. The obtained structure and the remnant stress, 2nd and 3rd order, mosaic blocks and atomic position were evaluated by using FullProf and GSAS (JINR Dubna-Russia and UAIC Iasi, Romania). Magnetic investigation were performed on a Foner magnetometer (NIRDTP Iasi, Romania).

The obtained spintronic devices – spin valves – were tested for magnetoresistance with a physical properties measurement system (PPMS, from Quantum Design (Model QD6000), in a four-point probe arrangement.

Transport phenomena were performed on a installation constructed at FLNP-JINR, Dubna, Rusia.

Director proiect,

IACOMI FELICIA