Italian National Conference on Condensed Matter Physics (Including Optics, Photonics, Liquids, Soft Matter)

Palermo, September 28 - October 2, 2015

BOOK OF ABSTRACT

Editors

Flavio Seno
University of Padova

Davide Valenti
University of Palermo

ISBN 978-88-907460-8-6

UNIVERSITÀ DEGLI STUDI DI PALERMO

Dipartimento di Fisica e Chimica

#P113 - Dosimetry to Electron Spin Resonance (ESR) using organic compounds (alanine and ammonium tartrate) for mixed neutron-gamma fields

Maurizio Marrale - Department of Physics and Chemistry, University of Palermo and INFN Catania Section

Other Authors: Anna Longo (Department of Physics and Chemistry, University of Palermo and INFN Section of Catania), Salvatore Panzeca (Department of Physics and Chemistry, University of Palermo and INFN Section of Catania), Salvatore Gallo (Department of Physics and Chemistry, University of Palermo and INFN Section of Catania and PH3DRA Laboratories, University of Palermo), Elio Tomarchio (DEIM of University of Palermo), Daniele Dondi (Department of Chemistry, University of Pavia and INFN Section of Pavia), Alberto Zeffiro (Department of Chemistry, University of Pavia and INFN Section of Pavia), Maria Brai (Department of Physics and Chemistry, University of Palermo and INFN Section of Catania)

Alongside with the development of Neutron Capture Therapy (NCT) and the use of thermal neutrons for radiotherapeutic purposes, many efforts have been devoted to the characterization of the beam in order to optimize therapy procedures. Reliable dose measurements should be able to determine the various (neutrons and photonic) components of the mixed beam usually employed for therapy.

This paper studies the effect of additives such as Boric and Gadolinium nuclei on the sensitivity of neutron organic (alanine and ammonium tartrate) dosimeters analyzed through Electron Spin Resonance (ESR) technique. These dosimeters were exposed to a mixed (neutron-gamma) field mainly composed of thermal neutrons. The choice of ^{10}B and ^{64}Gd as nuclei additives is due to their very high capture cross section for thermal neutrons. Also, after the nuclear reaction with thermal neutrons are emitted particles, which in turn release their energy in the vicinity of the reaction site.

The irradiation with mixed (neutron-gamma) field were performed within the thermal column of the TRIGA reactor, University of Pavia. Dosimeters readout was performed through the Electron Spin Resonance (ESR) spectrometer Bruker ECS106 located at the Laboratory of Dosimetry ESR / TL of the Department of Physics and Chemistry - University of Palermo.

We found that the addition of Gadolinium allows to largely increase the sensitivity of the dosimeters for thermal neutrons. In particular, a low concentration (5% by weight) of gadolinium oxide leads to an improvement of the sensitivity of neutrons more than 10 times. In addition, for this low content of gadolinium the photon tissue equivalence is not heavily reduced. This experimental analyses are compared with computational analyses carried out by means of Monte Carlo simulations performed with the MCNP (Monte Carlo N-Particle) transport code. A good agreement was observed for alanine dosimeters.

#P114 - Agarose and PVA Fricke gel dosimeters exposed to clinical photons beams: Nuclear Magnetic Resonance Relaxometry and Imaging

Maurizio Marrale - Department of Physics and Chemistry, University of Palermo and INFN Catania Section

Other Authors: Cesare Gagliardo (Department of Biopathology, Forensic and Medical Biotechnology, University of Palermo), Salvatore Gallo (Department of Physics and Chemistry, University of Palermo and INFN Catania Section and PH3DRA Laboratories, University of Catania), Giuseppina Iacoviello (U.O.C. Medical Physics, ARNAS Civico Palermo), Anna Longo (Department of Physics and Chemistry, University of Palermo and INFN Catania Section), Luigi Tranchina (Laboratorio di Fisica e Tecnologie Relative - UniNetLab, University of Palermo), Giorgio Collura (Department of Physics and Chemistry, University of Palermo and INFN Catania Section), Luigi Lazzeri (Department of Civil and Industrial Engineering, University of Pisa), Salvatore Panzeca (Department of Physics and Chemistry, University of Palermo and INFN Catania Section), Maria Brai (Department of Physics and Chemistry, University of Palermo and INFN Catania Section), Francesco d'Errico (Department of Civil and Industrial Engineering, University of Pisa and M Magnetic Resonance Research Center, School of Medicine of Yale)

Fricke Xylenol Gel (FXG) dosimetric system is based on the radiation induced oxidation of ferrous (Fe^{2+}) to ferric (Fe^{3+}) ions.

The application of Fricke gels for ionizing radiation dosimetry is continuously increasing worldwide due to their many favorable properties. However, one of their shortcomings is that ferrous and ferric ions diffuse in the gel matrix. To maintain the spatial integrity of the dose distribution, Fricke gels must be undergoing measurement within a few hours of their irradiation, so that ferric ions remain close to their point of production. Thus, the spatial integrity of the dose distribution in the Fricke gel is maintained.

The gel matrix also contributes to the oxidation of ferrous ions during irradiation, increasing the chemical yield of ferric ions in aqueous solution and increasing the sensitivity of the dosimeter.

The oxidation of ferrous ions also causes a reduction of the longitudinal nuclear magnetic relaxation time T_1 which can be measured by means of Nuclear Magnetic Resonance Relaxometry (NMR) and Magnetic Resonance Imaging (MRI).

The results presented are related to an experimental investigation conducted on Fricke Gels characterized by gelatinous matrix of Agarose or PVA.

We performed NMR relaxometry investigations which allow for direct measurements of the relaxation times in samples exposed to clinical photon beams. The main dosimetric features of the NMR signal were investigated. The gels were irradiated in the clinical dose range between 0 and 20 Gy. In order to assess the photon sensitivitywe analyzed the dependence of NMR relaxation time on radiation dose with varying ferrous ammonium sulfate content inside FXGs. Furthermore, signal stability was followed for several days after irradiation.

These measurements were preliminary to MRI analysis which can permit 3D dose mapping. In order to optimized the MRI response a systematic study was performed to optimize acquisition sequences and parameters. In particular, we analyzed for inversion recovery sequences the dependence of MRI signal on the repetition time T_R and on the inversion time T_I.

The dose calibration curves are reported and discussed from the point of view of the dosimeter use in clinical radiotherapy. This work has highlighted that the optimization of additives inside gel matrix is fundamental for optimizing photon sensitivity of these

detectors. We can conclude that FXG dosimeters with optimal ferrous ammonium sulfate content can be regarded as a valuable dosimetric tool to achieve fast information on spatial dose distribution.

#P115 - Functional oxides for nano-eletronics and spintronics

Giuseppe Maruccio - University of Salento

Other Authors: Anna Grazia Monteduro a,b, Zoobia Ameer a,b, Silvia Rizzato a,b, Chiara Leo a, Shilpi Karmakar c, Vittorianna Tasco b, Anna Paola Caricato a, Maurizio Martino a, D.D. Sarma d, Ross Rinaldi a,c, Giuseppe Maruccio a,b a Department of Mathematics and Physics University of Salento, Lecce, 73100, Italy b CNR-Institute of Nanotechnology, Lecce, 73100, Italy c CNR-Institute of Nanoscience, Lecce, 73100, Italy d SSSC Indian Institute of Science, Bangalore, 560012, India

Complex transition metal oxides present interesting physical phenomena, such as high dielectric permittivities, ferroelectricity and multiferroicity. Their extreme sensitivity to structural distortions and crystal chemistry offers many routes to control these properties. Here we report our activity on multiferroic and high-k oxides.

$BiFeO_3$ (BFO) is a promising multiferroic material for its high ordering temperatures far above room temperature (Néel temperature T_N = 643K and a ferroelectric ordering below T_c=1103K). A robust and large exchange bias effect has been demonstrated at room temperature in BiFeO3/CoFeB heterostructures. The exchange bias and magnetoelectric coupling at a BFO/ferromagnet interface can play a key role in the development of electrically controlled spin devices.Our activity ranges from target preparation and optimization to a systematic study of thin films deposited by PLD. The realization of targets with phase and stoichiometry control still represents a significant task, since the quality of the BFO film strongly depends from target characteristics. Structural, dielectric and ferroelectric characterizations of both bulk and thin films were performed using X-Ray Diffraction, impedance spectroscopy and ferroelectric characterization by means of a train pulses technique, named PUND (positive-up negative-down), and piezoresponse force microscopy (PFM). A systematic study was then performed to understand the role of each deposition parameter, such as substrate temperature, oxygen pressure on the structure and impure phase formation during BFO film growth. It was found that a non-stoichiometric target is preferable to limit the effect of bismuth losses and contain the impure phase formation. Increasing the oxygen pressure, improved dielectric properties have been observed, due to the decreasing number of oxygen vacancies.

Bulk Y_2CuTiO_6 (YCTO) showed high dielectric constant (ε') and very small dielectric loss. In resonators, antennas and transmitters, a high dielectric constant and a low dielectric loss are important to miniaturize the devices and reduce the bandwidth. Moreover, novel materials with improved dielectric properties are required to enhance the performance of CMOS field-effect transistors and to allow further miniaturization. However a quantitative analysis of the thin films is necessary for device applications. In our work we compared the dielectric properties of YCTO thin films prepared by PLD and characterized for their dielectric properties in comparison with SiO_2 and MgO. The dielectric constant of YCTO thin films was found to vary from 22 up to 100 at 100 kHz for the films deposited at 0.5 and 0.05 Pa oxygen pressure, respectively. This last value is about 25 times higher than for SiO_2 and 10 times higher than MgO.

Work to implement these materials in electronic and spintronic devices is currently in progress.

#P116 - Nanocomposite based on Multi-Macrocyclic Receptors and Halloysite for Volatile Organic Compounds Capture

Stefana Milioto - Università degli Studi di Palermo

Other Authors: Giuseppe Cavallaro (Dipartimento di Fisica e Chimica, Università degli Studi di Palermo), Giuseppe Lazzara (Dipartimento di Fisica e Chimica, Università degli Studi di Palermo), Marina Massaro (Dipartimento STEBICEF, Università degli Studi di Palermo), Renato Noto (Dipartimento STEBICEF, Università degli Studi di Palermo), Filippo Parisi (Dipartimento di Fisica e Chimica, Università degli Studi di Palermo), Serena Riela (Dipartimento STEBICEF, Università degli Studi di Palermo)

Volatile organic compounds (VOCs) are chemicals released to the atmosphere by natural and anthropogenic sources. VOCs are hazardous air pollutants and promote formation of photochemical smog. Variety of chemicals released from pharmaceutical industry includes priority pollutants like benzene, toluene, and dichloromethane. The aim of this work was at designing, preparing and characterizing from the physico-chemical view-point a pseudo nano-sponge with low environmental impact for pollutant removal. As adsorbent material, a nanocomposite based on nanoclay and cucurbiturils, which are biocompatible materials, were investigated.

Clay minerals (e.g. montmorillonite and kaolin) are important components of soils and sediments. Many have strong sorption affinities, large specific surface areas and high cation exchange capacities. These aluminosilicates have been tested since more than 40 years ago in the removal of toxic metals or organic pollutants. Among the aluminosilicates, halloysite ($Al_2Si_2O_5(OH)_4 \cdot nH_2O$) is a special nano-geomaterial because of its tubular morphology, high porosity and tunable surface chemistry which enabled it to be utilized as a promising adsorbent for various organic pollutants.

Cucurbiturils are cyclic polymers of glycourils which can exhibit similar host–guest chemistry as cyclodextrins. There are different homologues of cucurbiturils among which CB[8] selected in this work can hold small gas molecules, aliphatic and aromatic guests.

The adsorption capability of hybrid nano-sponge was investigated and correlated to the structural feature of the adsorbent sustainable nanomaterial. Toluene was selected as contaminant prototype.

Acknowledgments. The work was financially supported by the University of Palermo, PRIN 2010-2011 (prot. 2010329WPF)