PHYSICS AND MATHEMATICS PAPER ABSTRACTS

ENERGY HARVESTING AND STORAGE USING SMART NANOCOMPOSITE FILMS. *JEMILIA POLIUS*, ALABAMA A&M UNIVERSITY.

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Smart nanocomposite materials with energy harvesting and storage capabilities have been of great scientific and technological interest. Many smart materials have been classified as piezoelectric materials, which have been widely used for sensors, actuators, and transducers. Among different nanomaterial, the ZnO nanostructure possess a special place, due to its merits, such as, high specific surface area, optical transparency, nontoxicity, chemical, and photochemical stability, ease of fabrication and electrictrochemical. To date, this concept has not been explored, in particular, based on single smart-material(s) via both pyroelectricity and piezoelectricity. This study will explore doped metallic paint as a smart-material for energy harvesting applications. The present research will focus the following: (1) the optimization of the incorporation of the ZnO material in metallic paint; (2) the utilization of the dip coating method to deposit ZnO doped metallic paint on a copper substrate; (3) the determination of the structural and electric properties of thick films with respect to the dopant concentrations of the coatings; and (4) the suitability of the fabricated films for energy harvesting, energy storage and sensor applications. The results of these experiments will contribute toward understanding the interactive effects of the ZnO doped metallic paints, and the future production of energy harvesting materials and sensor applications.

HIGH PRESSURE METHANE SORPTION IN MOF-199 AND ACTIVATED CARBON MSC-30. *JACOB BURRESS* AND DONALD BETHEA, UNIVERSITY OF SOUTH ALABAMA.

Concerns about global climate change have driven the search for alternative fuels. Natural gas (NG, methane) is a cleaner fuel than gasoline and abundantly available due to hydraulic fracturing. One hurdle to the adoption of NG vehicles is the bulky cylindrical storage vessels needed to store the NG at high pressures (3600 psi, 250 bar). The adsorption of methane in microporous materials can store large amounts of methane at low enough pressures for the allowance of conformable, ‚Äúflat‚Äù pressure vessels. The measurement of the amount of gas stored in sorbent materials is typically done by measuring pressure differences (volumetric, manometric) or masses (gravimetric). An instrument will be presented with which methane adsorption measurements can be performed using both volumetric and gravimetric methods in tandem. The gravimetric method presented has no buoyancy corrections and low uncertainty. Therefore, the gravimetric measurements can be performed throughout an entire isotherm or just at the extrema to verify the results from the volumetric measurements. Results from methane sorption measurements on an activated carbon (MSC-30) and a metal-organic framework (Cu-BTC, HKUST-1, MOF-199) will be shown. New recommendations for calculations of gas uptake and uncertainty measurements will be discussed.

XPS STUDIES OF SURFACE DEGRADATION OF CZT DUE TO THERMAL TREATMENTS. *JONATHAN LASSITER*, RAEQUANE JONES, ROBERT SMITH II, BEATRIZ GUTIERREZ-CEREZO, KALEN MUMFORD, MELISSA SMITH AND STEPHEN BABALOLA, ALABAMA A&M UNIVERSITY.

In order to understand the contributing factors responsible for the changes in electrical properties and detector function induced by annealing, CZT samples were treated in the temperature range of 100 - 400o C. Following each thermal treatment, X-ray photoelectron spectroscopy was performed in order to determine changes in the surface chemistry. These changes in the surface are indicative of alterations in the oxide profile, as well as deteriorating surface material quality. Electrical properties improved in the lower range of treatment, and this was most notable in the
200 and 300 degree Celsius cases. In contrast, electrical properties were shown to significantly degrade at 400 degree Celsius. The surface presence of ZnO, and changes in tellurium oxide types contributed to the degradation in electrical properties of the material.

CURRENT VOLTAGE CHARACTERISTICS OF CDZNTE-BASED RADIATION DETECTORS. *ROBERT SMITH*, MELISSA SMITH, BEATRIZ GUTIRREZ-CEREZO, KALEN MUMFORD, JONATHAN LASSITER AND STEPHEN BABALOLA, ALABAMA A&M UNIVERSITY.

Current voltage (I-V) characteristics of a device are the profiles obtained when the current, generated from applying a bias to the device, are plotted against the applied bias. The plot enables the use of Ohm's law to deduce the resistance and resistivity of the device, as well as provide an insight into the performance of the device, especially at saturated current values. In this study the electronic device used is fabricated using cadmium zinc telluride (CdZnTe) crystal. The CdZnTe crystals are used for radiation detection especially in gamma and x-ray radiation, as well as in other medical, astronomical and industrial applications. We compared the I-V curves obtained from CdZnTe crystals that were heated in the furnace. We connected the furnace to the I-V system and received the current voltages from the CdZnTe crystals from room temperature to 500 degrees Celsius in 100-degree increments. We completed four sweeps for each temperate and while doing this we ramped the steps from -10 volts to 10 volts in increments of 0.5 volts and -200 volts to 200 volts in increments of 10 volts. Our results show a pattern of increasing current as temperature increases, up to between 200 and 300 degrees Celsius. As bias increased at 300 Celsius and above, the observed I-V plot displays a stochastic profile. This profile deviates from that predicted by Ohm's law, and we believe that the electrical properties, specifically the resistivity of the device, have been altered at higher temperatures.

EFFECTS OF CNT/MWCNT ON PVDF OPTICAL CHARACTERISTICS. *POWELL RACHEL* AND PADMAJA GUGGILLA, ALABAMA A&M UNIVERSITY.

There are numerous applications for the pyroelectric composite films especially in medical field, military, and environmental applications etc. The main focus of this research is to address the problem of making the flexible films and doping them with CNTs and MWCNTs and

improve their efficiency as optoelectronic devices. This research reports the fabrication technique used in making PVDF and PVDF doped by CNT, PVDF+LiTaO3, PVDF+LiTao3+MWCNT films and their electrical and optical characteristics. Doping with CNT and MWCNT enhanced the optical characteristics of teh PVDF films and were acting more like conductors than semiconducting materials. The Fourier Transform Infrared Spectroscopy has been recorded in
the range 500 to 4000 cm-1. Raman Spectrum of the films is also obtained.

ON SCHUR'S UNITARY TRIANGULARIZATION THEOREM. *WEN YAN*, TUSKEGEE UNIVERSITY.

By the well known Schur's triangularization theorem, for any n by n complex matrix A in M(n), there is a unitary matrix U such that U*AU (also in M(n)) is upper triangular. The diagonal entries of U*AU are eigenvalues of A. The author studies similar results on complex skew symmetric matrices in so(n) and complex matrices in sp(2n,C).

A CONSIDERATION OF THE SOLITON SOLUTION TO THE KORTEWEG-DEVRIES EQUATION AND THE USE OF GREEN'S FUNCTIONS TO SOLVE INHOMOGENEOUS DIFFERENTIAL EQUATIONS WITH VARIANT BOUNDARY CONDITIONS. *SAMUEL UBA*, MATTHEW EDWARDS, YINSHU WU AND FAYEQUA MAJID, ALABAMA A&M UNIVERSITY.

Theoretical Efforts continue to be made to have readily available solutions to both inhomogeneous linear and non-linear differential equations. To that end, we report here our investigation of Green's functions to obtain solutions to first and second order inhomogeneous equations with specific boundary conditions. Once the Green's function has been determined, a simple integration allows the solution to be obtained. Additionally, the soliton solution to several non-linear differential equations is known to exist. Here, we reconsider the soliton wave for the Korteweg-DeVries equation and illustrate the unchanging shapes of two solitons following a head-on collision.

AN INVERSION ALGORITHM FOR SUBSURFACE SENSING PROBLEM. *YIJUN YU*, TUSKEGEE UNIVERSITY. NAILONG GUO, BENEDICT COLLEGE.

An inversion algorithm with Bayesian Formulation is considered for subsurface Sensing problem. The algorithm inverts the parameters of a heterogeneity profile based on measured scattering data. The Algorithm is developed based on assumption that there is a mismatch between the measured data and the model employed, with the error represented as a random process. Here the basic Bayesian inversion framework is presented, with example results presented for subsurface-sensing problems.

HAMILTONIAN STRUCTURES ON SPIN(7)-GEOMETRY. *KEVIN INGLES*, UNIVERSITY OF SOUTH ALABAMA. AJ TODD, N/A.

Hamiltonian structures are those that give the solutions to Hamilton's Equations. In this paper, we aim to characterize these Hamiltonian structures for Spin(7) geometry.

CREATING DIFFRACTION GRATINGS WITH TRANSMISSION HOLOGRAPHY. *JAMES MCKEE* AND DAVID THOMPSON, UNIVERSITY OF NORTH ALABAMA.

We used transmission holography to create diffraction gratings to disperse visible light wavelengths. A green SLM laser was used to create a one inch diameter collimated beam at normal incidence to a holographic plate. The transmitted beam was re-directed so that it was transmitted through the plate a second time from the same side as the initial beam, with angle of incidence ranging from 5 to 30 degrees. The resulting holograms consisted of diffraction gratings with line spacing between 400 and 1700 lines/mm. A quadratic fit to measurements of angle of incidence versus the resulting grating's line spacing values allowed us to create diffraction gratings with standard line spacing of 300, 600, and 1200 lines/mm.

A NOVEL THEORETICAL MODEL FOR ATOMS INSPIRED BY COMMUNICATION THEORY. *SERKAN G√ºLDAL*, LURONG PAN AND MURAT TANIK, UNIVERSITY OF ALABAMA AT BIRMINGHAM.

In modern physics and chemistry theories, atoms are considered basic building blocks of the material world. Computational modeling for atoms is a useful technique in studying and predicting events in chemical, mechanical, electrical, biological, planetary, and cosmological systems. Due to the complexity and wide scale range of particle systems, current computational modeling approaches including quantum mechanics (QM), density functional theory (DFT), and molecular mechanics (MM) are separately designed to describe systems at different size and precisions, in which atoms are represented quite differently.

More specifically, they are based on completely different physics models and theories with various advantages and disadvantages and no consistency between these models. This reductionist scientific approach has great practical values in investigating particle structures and mechanisms in separated scales, but also faces huge challenges in terms of theoretical perfection, physical accuracy, multi-scale integration, and computational scalability. In this paper, we proposed a novel theoretical physics model to describe the physical phenomena from a completely different perspective inspired by communication theory. We call this model communication dynamics (CD). This model approaches to current theoretical physics from computational modeling perspective with inherent description of integrated space and time. In this work, we proposed a theoretical model for atoms in the periodic table as an example to reveal one of applications of this model. Our model aims to use a uniformly applicable mathematical formula to describe physical realities at different scales, even for particles exhibit particle-wave duality.

PHYSICS AND MATHEMATICS POSTER ABSTRACTS

A PRODUCT PROPERTY FOR DISCRETE TIME LAGUERRE FUNCTIONS. *PHILIP OLIVIER*, UNIVERSITY OF SOUTH ALABAMA.

A "product property" for discrete time Laguerre functions is presented. Several corollaries to this theorem are presented. The product property is applied to convenient computation of convolution sums.

MODERATE TEMPERATURE DIELECTRIC SURFACE AND VOLUME CURRENTS AND LOW-FREQUENCY DIELECTRIC CONSTANT MEASUREMENTS OF PURE AND MULTI-WALLED CARBON NANOTUBES (MWCNT) DOPED AMORPHOUS POLYVINYL ALCOHOL THIN FILMS. *ANGELA REEDY*, MATTHEW EDWARDS, PADMAJA GUGGILLA AND AFEF JANEN, ALABAMA A&M UNIVERSITY. QURATULANN IJAZ, TROY UNIVERSITY.

Previously, we have reported measurements of the temperature-dependent surface resistivity of pure and multi-walled carbon nanotubes doped amorphous Polyvinyl Alcohol (PVA) thin films. In the temperature range from 22 0C to 40 0C with a humidity-controlled environment, we found the surface resistivity to decrease initially but to rise steadily as the temperature continued to increase. Also, electric surface current densities (Js) were measured on the surface of pure and MWCNT doped PVA thin films. At low voltages, these densities were found to be produced analogously to ohmic conduction. However, unlike ohmic conduction in metals where free electrons exist, some captive electrons are freed to become conduction electrons from increased thermal vibration of constituent atoms in amorphous thin films. Finally, we present conventional volume resistivity measurements in the same temperature range, with the recognition that nano-dopants, microscopic structure, and environmental conditions contributed to the unique physical properties of these material systems.

CALCULATING THE DIMENSIONS OF THE PEAR-SHAPED EARTH'S HEMISPHERES. *ALMUATASIM ALOMARI*, ARJUN TAN AND MARIUS SCHAMSCHULA, ALABAMA A&M UNIVERSITY.

The orbital analysis of artificial earth satellites have revealed the 'pear-shape' of the the earth with the 'stem' of the pear at the north pole. Because of the anti-symmetric nature of this shape, the two hemispheres are unequal in all measures. The dimensions of the two hemispheres are calculated and compared. The southern hemisphere is on average 5.092 m higher than the northern hemisphere. The surface area of the southern hemisphere is 408.534 sq km larger than that of the northern hemisphere. Finally, the volume of the southern hemisphere is 1,304,204 cu km greater than that of the northern hemisphere.

INFRARED MICROSCOPY AND IMAGE ANALYSIS OF CZT. *MELISSA SMITH*, BEATRIZ GUTIERREZ-CEREZO, KALEN MUMFORD, ROBERT SMITH II, KRISTINA WILLIAMS, JONATHAN LASSITER AND STEPHEN BABALOLA, ALABAMA A&M UNIVERSITY.

Cadmium Zinc Telluride (CZT) crystals have the ability to detect high energy radiation such as gamma rays and x-rays, operating at room temperature. These crystals contain tellurium inclusions, which trap electrons. This trapping of electrons decreases the collection efficiency, and resolution of CZT-based radiation detectors. (CZT) is transparent to infrared light, as such, infrared microscopy was used to determine the number and morphology of the tellurium inclusions within the bulk of the crystals. We characterized samples that were annealed at different temperatures, in the range of 100 – 400degC, and were compared to the unannealed samples. Infrared micrographs of the annealed samples were compared to their room temperature baselines. Treatments with higher temperatures showed the appearance of smaller inclusions. This may be attributed to the inclusions breaking down, and diffusing into the bulk of the crystal.

OPTIMIZATION OF PHOTOCATALYTIC AIR DISINFECTION. *SALIMU KUMASI* AND PRAKASH SHARMA, TUSKEGEE UNIVERSITY.

Photocatalytic air disinfection (PAD) systems are researched thoroughly towards increasing their maximum efficiency and rate of disinfection processes. Various parameters such as light irradiation, photocatalytic air filter location, gas purging and sampling etc. were optimized via experimental models and develop a model for inactivation of microbes in a filter fiber media using mathematical and experimental data. The ultimate goal of this task is to ensure that the proposed models are true representations of photocatalytic air disinfection. The models developed in this research will be validated with experimental results from a full-scale instrumentation setup in the laboratory.

Acknowledgements: The authors will like to acknowledge NSF for providing funding to support the work.

NANOMATERIALS DRIVEN ENERGY. *SALIMU KUMASI*, PRAKASH SHARMA AND AKSHAYA KUMAR, TUSKEGEE UNIVERSITY.

We have developed nanofibers, nanotubes, nanoparticles, nanocatalysts nanostructures for clean energy. Energy can neither be created nor be destroyed, but it can be converted from one form to another. Based on this principle, chemical energy such as hydrogen produced from water electrolysis at a much lower voltage using RuO2 nanoparticles on the Si wafer substrate. The hydrogen is produced from the clean sources such as solar energy and water, it has to be stored by physisorption or chemisorption processes on to the solid state systems.

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OXIDATION ENHANCEMENT BY UTILIZING THE SOLAR ENERGY. *SALIMU KUMASI*, PRAKASH SHARMA AND AKSHAYA KUMAR, TUSKEGEE UNIVERSITY.

For the successful physical adsorption of hydrogen molecule, we have developed novel polyaniline nanostructures via chemical templating and electrospinning Chemical or complex hydrides involving nano MgH2 and transition metal nanocatalysts have been synthesized to tailor both the thermodynamics and kinetics of hydrogen (chemi) sorption respectively. Utilization of solar energy (UV-Vis) and a coupling of novel semiconductor oxide nanoparticles have been recently demonstrated with enhancement in oxidation and/or photo-reduction processes for the water/air detoxification and sustainable liquid fuel production respectively. Magnetic nanoparticles such as ZnFe2O4 have been synthesized and optimized for biomedical applications targeted drug delivery and tumor diagnostic sensing (MRI).

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