International Workshop on Advanced Electrical and Electronic Engineering 2018 (IWAEEE2018)

Zhejiang University - Gunma University of 4th International Summer School of graduate students, Zhejiang University

14th, Sept. & 17-18 Sept., 2018

201, Motor Hall, Zhejiang University, China

Program Committee

Prof. Hiroshi Sakurai (*Gunma University, Japan*)

Prof. Jianxin Shen (*Zhejiang University, China*)

Prof. Hayato Sone (*Gunma University, Japan*)

Prof. Tao Wang (*Zhejiang University, China*)

Prof. You Yin (*Gunma University, Japan*)

Scope

The scopes of International Workshop on Advanced Electrical and Electronic Engineering 2018 (IWAEEE2018) are as follows,

- Artificial Intelligence (Materials, Device, Circuits & System)
- Internet of Things (Circuits & System)
- Sensors
- Nonvolatile memories
- Advanced electronic materials
- Physics in electronics
- Advanced semiconductor
- Circuits
- Communications

Venue

Room 201, Motor Hall, Yuquan Campus, Zhejiang University, China

Program

Welcome address

17th Sept., Monday

Session 1

(13:00 - 13:20) **(Invited)** Prof. Hiroshi Sakurai (*Gunma University, Japan*)

Applications of Compton scattering to material science and imaging

Coauthors: Hiroshi Sakurai and Kosuke Suzuki

Abstract: The Compton effects are well known as the experimental evidence of particle-like behavior of light. A. H. Compton proved that "a photon directed momentum, *hv*/*c*, as well as energy *hv*" from the Compton scattering experiments. However, Compton scattering can also probe wave functions of electrons in materials, in other words, chemical bonding. Furthermore, we can get non-destructive images of light elements using Compton scattering with high energy X-rays. In this study we talk about our recent studies of electronic structure of Li ion battery (LIB) materials ($LiMn_2O_4$, $LiCoO_2$ and $LiFePO_4$). Furthermore, we talk about non-destructive images of Li ions in an LIB.

(13:20 - 13:40) **(Invited)** Prof. Tao Wang (*Zhejiang University, China*)

Some topics in nano electronics

Abstract: IC is really the nano technology, since chip critical size is 90nm about ten year ago. Some topics about devices are ongoing till now and 3 interesting study are presented today. The one method of Si nanowire fabrication is introduced and its gate-all-around devices are shown together. The graphene/Cu interface is another meaningful interface, which was investigated by experiments and simulation. The light current at different nano wire and tube and 2D films are compared in the terms of theory.

(13:40 - 14:00) **(Invited)** Prof. You Yin (*Gunma University, Japan*)

Ultralow-Volume- Change Phase-Change Materials and High-Performance Memory Devices for IoT Application

Abstract: In this talk, phase-change materials and memory devices for internet of everything (IoT) application will be discussed. For better reliability and retention, doping N into GeTe with a fast operation speed was investigated with the aim of reducing the volume change upon crystallization. For high-density, the multilevel storage was investigated using SbTeN-based devices and several resistance levels with good stability were demonstrated, which resulted mainly from the gradual enlargement of crystalline region between electrodes by Joule heating. For low power consumption, phase-change memory (PCM) incorporated with nanostructures was investigated and was proved to be very energy-efficient.

(14:00 - 14:15) Mr. Zhuhaobo Zhang (*Zhejiang University, China*),

An Inductive Power Transfer System Design with Large Misalignment Tolerance for EV Charging

Abstract: Inductive power transfer (IPT) technology is becoming more and more attractive for electric vehicle charging due to its safe, flexible and convenient features. The main drawback of IPT system is the large leakage inductance, especially when there is misalignment between the pads. The misalignment reduces coupling and reduces the overall efficiency. This paper proposes an IPT system with large misalignment tolerance which combines the characteristics of a new solenoidal-bipolar transformer and a parallel circuit topology for the secondary side. The system design and performance are simulated with a 3D finite element modeling (FEM) tool and experimentally verified on a 3kW prototype. A 350 mm misalignment tolerance range for either lateral or vertical direction is achieved with a 600 mm2 transformer and a 200 mm air gap.

(14:15- 14:30) Mr. A. Terasaka (*Gunma University, Japan*)

Measurement of non-destructive Li reaction distribution of deteriorated battery using Compton scattering method

Coauthors: A.Terasaka, K. Suzuki*, D.Hiramoto N. Tsuji, Y. Orikasa, Y. Uchimoto, Y. Sakurai and H. Sakurai

Abstract: We have developed in-operando technique for the lithium-ion batteries using high-energy X-ray Compton scattering. The Compton scattering is experimental technique to measure momentum density distribution of the electrons. Advantages of this technique are a usage of high-energy X-rays, over 100 keV, as incident beam and the line-shape of Compton scattered X-ray energy spectrum, so-called Compton profile, depend on the elements. The high-energy X-rays which have high-penetration power permit us to measure the reaction in closed electrochemical cells in operando condition. The line-shape of Compton scattered energy spectrum enable us to quantitate Li concentration which contributed charge-discharge process.

In this study, we applied this technique to a commercial coin cell lithium-ion battery, VL2020 and Li reaction distribution of SOC 0 and SOC 100 was measured using flesh and fade batteries. In flesh battery, Li reaction accompanying charge and discharge was observed. Fade battery did not respond to charge / discharge. Instead, it is predicted that there is a new structure at the separator-positive electrode interface. We also found that the negative electrode expands.

(14: 30- 14:45) Mr. Siyang Sun (*Zhejiang University, China*)

Optimal Temporal-spatial Electric Vehicle Charging Demand Scheduling Considering Transportation-Power Grid Couplings

Abstract: This paper proposed a holistic temporal-spatial scheduling approach for charging demand (both fast charging and normal charging) of plug-in electric vehicles (PEVs). The proposed solution aims to optimally schedule the PEV charging actions based on PEV operational states with minimized charging costs and travel time, whilst meets the constraints of both transportation and power distribution networks. The power utility can also participate in the scheduling strategy by adopting real-time pricing (RTP) to increase the utilization efficiency of distributed generation (DG) and optimize the profiles of power distribution networks. The proposed solution was assessed through a set of case studies and the numerical results clearly demonstrated the effectiveness of the proposed strategy.

(14:45- 15:00) Mr. K. Haishi (*Gunma University, Japan*)

Magnetization switching behavior for CoFeB/MgO and CoFeB/Ta multilayer films,

Coauthors: K. Haishi, A. Shibayama, M. Adachi, H. Sakurai, K. Suzuki, K. Hoshi, M. Yamazoe, M. Itou, N. Tsuji and Y. Sakurai

Abstract: Recently, Ta/CoFeB/MgO/CoFeB/Ta magnetic tunneling junction (MTJ) films with perpendicular magnetic anisotropy (PMA) are interesting because PMA can reduce the critical current for current-induced magnetization switching. It was reported that the PMA comes from the MTJ interface of the films. Therefore magnetization switching of the MTJ interface is a key characteristic of a spintronic device.

Magnetic Compton profile (MCP) measurement can probe the spin selective magnetization. In this paper, we report magnetization switching behavior of the spin selective magnetic hysteresis (SSMH) curves, orbital selective magnetic hysteresis (OSMH) curves for CoFeB/MgO and CoFeB/Ta multilayer films from the view-point of the magnetization switching behavior with the PMA.

The SSMH curves of the CoFeB/MgO and CoFeB/Ta multilayer films show magnetic shape

anisotropy of an in-plane magnetic anisotropy. However, the OSMH curves of the CoFeB/MgO and CoFeB/Ta multilayer films show a step-function-like behavior with rather small magnetization switching fields as if they possess PMA.

Break 15min

Session 2

(15:15- 15:30) Mr. Zhihong Cui (*Zhejiang University, China*)

A Study on the Shielding for Wireless Charging Systems of Electric Vehicles

Abstract: With a high power level and a large transfer distance in a wireless charging system of electric vehicles, human exposure to electromagnetic filed becomes a major concern. In this paper, some key parameters of an aluminum plate and ring shield are studied with the aid of finite-element analysis. The shielding effectiveness and the power transfer efficiency are investigated simultaneously as one of the parameters changes. It is found that the shielding effect mainly depends on the size of the shield while increasing the distance between the shield and the ferrite layer attenuates efficiency drop due to the eddy-current loss in the shield. A 3.3kW wireless charging system with 20cm air gap was built to verify the simulation results.

(15: 30- 15:45) Mr. K. Oshima (*Gunma University, Japan*)

Fabrication of N-type Silicon Nanowire Biosensor for Sub-10-Femtomolar Concentration of Immunoglobulin

Coauthors: Tomoya Tashiro, Hui Zhang, Kakeru Oshima, Yuya Sakurai, Takaaki Suzuki, Noriyasu Ohshima, Takashi Izumi, Hayato Sone

Abstract: A simple fabrication process of an n-type silicon nanowire (SiNW) biosensor for sub-10 femtomolar (fM) concentration immunoglobulin detection was presented in this work. The SiNWs with different widths of 80-190 nm were fabricated using electron beam lithography and reaction ion etching techniques. The electrical characteristics of SiNWs with various widths were measured. And it can be observed that thin SiNW has high resistance, which is in agreement with electrical resistance theory. Furthermore, the surface of the fabricated SiNW was functionalized by 3-aminopropyltriethoxysilane for making the biosensor device to detect the binding of immunoglobulin G (IgG) molecules. The responsivity of the biosensor was investigated by observing electrical performance in response due to IgG with various concentration from 6 fM to 600 nanomolar (nM). The resistance changing ratio based on the current voltage (*I-V*) characteristics was analyzed and it increased with increasing of the IgG concentration. As a result, it demonstrated that the n-type SiNW biosensor has the ability to detect the IgG molecules with low concentration of 6 fM.

(15:45- 16:00) Ms. Jiaying Wang (*Zhejiang University, China*)

Optimal operation of commercial buildings with generalized demand response management

Abstract: With the development of smart grid technology, each entity in a power system, from power sources to end users, could have more intensive interactions with some others. In this paper, flexible loads and emerging concentrating solar power (CSP) plants are considered as generalized demand response resources and dispatched cooperatively to mitigate the problem of insufficient power supply during peak load periods. Numerous commercial buildings have great potential to provide dispatching flexibility for a power system through generalized demand response management. Given this background, an optimal operation model is presented with an objective of minimizing the total operational cost of a given commercial building with a CSP

plant, a heat pump, inflexible loads, electric vehicles (EVs), lighting systems and air conditioners included. A highly efficient solver YALMIP is next utilized in the MATLAB environment to solve the developed optimization model. Finally, an office building is employed to demonstrate the proposed optimal operation model.

(16:00 - 16:15) Mr. T. kato (*Gunma University, Japan*)

Formation of W Nanowire Using Electron Beam Lithography and Its Application to Highly Sensitive Gas Sensor

Coauthors: Takumi Kato, Naoki Sakuma, and Hayato Sone

Abstract: Gas sensors have a wide range of applications, especially have a role of preventing accidents caused by leakage of combustible gas. In this research, we aimed to form W nanowires using electron beam lithography, and to fabricate high-sensitivity and low-power gas sensor. It is a principle that combustible gases are detected by resistance change of the nanowires due to redox reaction on the nanowire surface by combustible gas.

We formed W film with a thickness of 45 nm using a rotating tray type DC sputtering apparatus. W nanowire sensor was fabricated by electron beam drawing and reactive ion etching. We confirmed that the nanowires were formed between two W electrode with a width of 84 nm to 259 nm using scanning electron microscope and height of 18.5 nm using atomic force microscope. Then, we measured the nanowire resistivity of 1.2×10^{-4} Ω· cm by current-voltage measurement system. As this value is slightly larger than the W resistivity, it is possible that the nanowire surface is oxidized. We are planning to detect combustible gas using fabricated sensor in future work.

(16:15- 16:30) Mr. Lei Ji (*Zhejiang University, China*)

An Optimized Control Strategy to Improve the Current Zero-Crossing Distortion in Bidirectional AC/DC Converter based on V2G Concept

Abstract: With the development of smart grid and new energy technology, V2G (vehicle-to-grid) has become a new research hotspot, and bidirectional converter plays an important role in it. In this paper, a bidirectional AC/DC converter using SiC device is developed, and unipolar PWM modulation is adopted in consideration of efficiency.

Compared with other modulation methods that are widely used, unipolar modulation has the advantages of low switching loss, small current ripple and small common mode noise, however the current is distorted at zero-crossing. With the investigation on the characteristics of the current zero-crossing distortion based on the AC/DC converter prototype, an optimized control strategy which generates the switching signal for the line frequency bridge based on the control loop output reference (CLOR) instead of the grid voltage is proposed. The performance of the analyses and the proposed strategy is verified by experiments.

(16: 30- 16:45) Mr. T. Wakahara (*Gunma University, Japan*)

Fabrication of Fluorescence Detection Optical System to Develop Scanning Near-Field Fluorescence Microscope

Coauthors: Takahiro Wakahara, Masayuki Ono, Sumio Hosaka, and Hayato Sone

Abstract: An observation technique of surface characteristics on biomaterials with highly resolution is desired in the field of biotechnology and medical science. In our laboratory, scanning near-filed optical microscope (SNOM) has been developed using atomic force microscope (AFM) system. In this research, we fabricated a fluorescence detection optical system to develop a scanning near-field fluorescence microscope for observation of fluorescent labeled biomaterials.

Firstly, we calculated the trancemittance of near-field light from an aperture which open the end of a metal coated probe tip using finite-difference time-domain (FDTD) method. The transmittance of 1.56% was obtained by the simulation result for the silver coated probe tip with the aperture diameter of 200 nm. Secondly, we exchanged mirrors in the microscope to apply the fluorescence light of blue laser as excitation source. As the result, the transmittance of the blue laser power was increased about 1.5 times larger than that before exchanging. Finery, we fabricated a metal thin film coated cantilever on a tip side, and tried to form a small aperture on the end of the tip by scratching method using contact mode AFM. We will evaluate the fluorescence image by the cantilever tip using scanning near-filed fluorescence microscope in future work.

(16:45- 17:00) Mr. Qiang Jiang (*Zhejiang University, China*)

Performance Investigation of a Five-phase MultiSegment Primary PMLSM for Ropeless Elevator

Abstract: In this paper, a novel multi-segment windings five-phase PMLSM applied in the ropeless elevator is proposed.Compare to three-phase machine, the five-phase machine can offer higher power density, which not only reduces the thermal stress and inverter capacity, but also improves the reliability and redundancy. So, the five phase PMLSM is the great candidate for the ropeless elevator. Moreover, the segment winding power feeding method will reduce the power consumption and improve the efficiency. To validating the superiority of the proposed method, the segment winding structure and several power feeding method are discussed in the paper. The back-EMF, average thrust force and thrust force ripple are compared with traditional method. Furthermore, the interval length between the primary have been optimized, it is founded when the length equal to the78 mm, the torque thrust enhanced by 6.72%. Finally, the researches about the electromagnetic performance under several wingdings switch failure mode.

(17:00 - 17:15) Mr. Y. Kobayashi (*Gunma University, Japan*)

Development of spectral CT system using CdTe detector

Coauthors: Yuki Kobayashi, Daiki Ono, Yosuke Harasawa, Akie Nagao, Naoki Sunaguchi, Kosuke Suzuki, Kazushi Hoshi, Masami Torikoshi and Hiroshi Sakurai

Abstract: Recently obtain electron density and atomic number measurements were reported by using spectral CT system. This method can be used for various purposes such as medical diagnosis and explosive detection. They used an energy selective multi-channel type line sensor. However, its accuracy is not enough especially for medical application. This can be ascribed to the variation of the each detector in the multi-channel type line sensor. Therefore, we suggest a single detector system, which has 1 channel CdTe cooled detector. The obtained X-ray attenuation coefficients of several samples were very close to the theoretical values. This indicates a possibility to obtain the electron density and atomic number with enough accuracy for medical application.

14th, Sept., Friday, Yuquan campus visiting

18th, Sept., Tuesday, Zhijinggang campus visiting

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