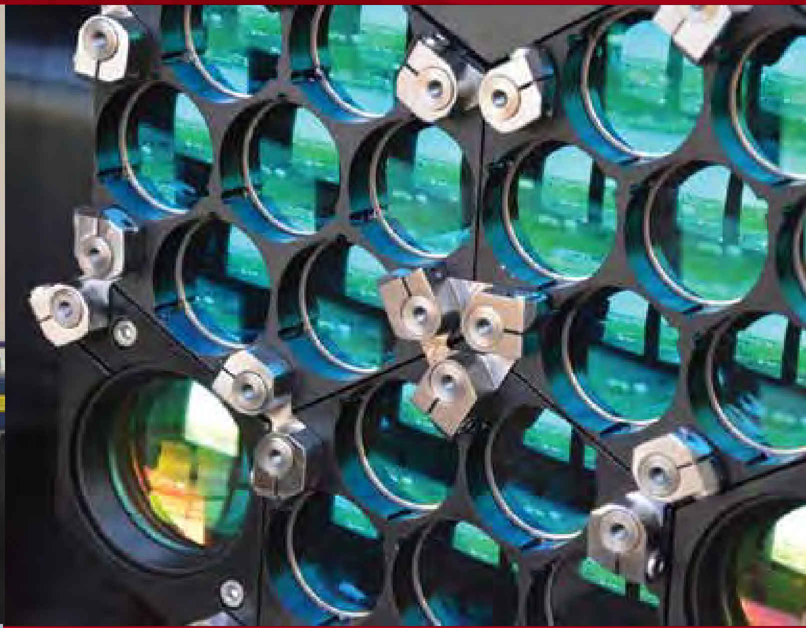
AGENDA

INTERNATIONAL WORKSHOP ON THIN-FILMS FOR ELECTRONICS, ELECTRO-OPTICS, ENERGY AND SENSORS (TFE3S)



July 4-6, 2015

University of Dayton China Institute — Suzhou, China

UNIVERSITY of DAYTON

International Workshop on Thin-films for Electronics, Electro-Optics, Energy and Sensors

go.udayton.edu/thinfilmworkshop

Suzhou, China
July 4-6, 2015

Organized by
University of Dayton, University of Dayton China Institute, Soochow University, and Nanjing University of Science and Technology
and
Suzhou Dushu Lake Science and Education Development, Co. Ltd.

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Vision and Topics

The University of Dayton's Center of Excellence for Thin-film Research and Surface Engineering (CETRASE) is delighted to organize its first international workshop at the University of Dayton's China Institute in the Suzhou Industrial Park (SIP), July 2015. The purpose of the workshop is to exchange technical knowledge and boost technical and educational collaboration activities within the thin film research community through CETRASE and the China Institute.

Topics include, but are not limited to:

1. Multifunctional oxide thin films
2. Carbon and noncarbon-based 2-D thin films
3. Thin film microelectronics
4. Flexible and printable thin films
5. Thin film metamaterials
6. Optics at the surface
7. Nonlinear optical thin films
8. Organic and biological thin films
9. Phase-change materials and other thin film sensor materials
10. Thin films for energy harvesting and energy storage
11. Novel processing, characterization techniques and applications of thin films

Manuscript Submission Instructions

The program committee welcomes all invited and contributing authors to submit a full-length manuscript for the proceedings of the TFE3S workshop. SPIE will publish the manuscripts.

Full Manuscript Submission Deadline: August 15, 2015

Full manuscripts of six to eight pages in length can be submitted for review. Figures should be clear enough with axis markings and legends that are legible. The technical program committee and session chairs will review the manuscripts for technical merit. A sample manuscript will be made available on the workshop website.

Manuscript submission will be through the SPIE website: **spie.org/x112457.xml**

The symposium code is **TFE3S15 for the manuscript submission**.

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TFE3S Agenda At-A-Glance

<table>
<tr><th></th><th colspan="2">Day 1 (July 4)</th><th colspan="2">Day 2 (July 5)</th><th colspan="2">Day 3 (July 6)</th></tr>
<tr><td>9-10:30 a.m.</td><td colspan="2">Opening Ceremony and Plenary Speakers (Room 203)</td><td colspan="2">Plenary Speaker (Room 203)</td><td colspan="2">Plenary Speakers (Room 203)</td></tr>
<tr><td colspan="7">Coffee Break (15 minutes)</td></tr>
<tr><td>10:45 a.m.-12:15 p.m.</td><td>Session 1A (Room 201)</td><td>Session 2 (Room 203)</td><td>Session 4 (Room 201)</td><td>Session 5 (Room 203)</td><td>Session 7 (Room 201)</td><td>Session 9 (Room 203)</td></tr>
<tr><td colspan="7">Lunch Break (75 minutes)</td></tr>
<tr><td>1:30-3 p.m.</td><td>Session 1B (Room 201)</td><td>Session 3A (Room 203)</td><td>Session 8A (Room 201)</td><td>Session 6 (Room 203)</td><td>Session 10B (Room 201)</td><td>Session 11 (Room 203)</td></tr>
<tr><td colspan="7">Coffee Break (15 minutes)</td></tr>
<tr><td>3:15-4:45 p.m.</td><td>Session 1C (Room 201)</td><td>Session 3B (Room 203)</td><td>Session 8B (Room 201)</td><td>Session 10A (Room 203)</td><td>CLOSING CEREMONY (Room 203)</td><td></td></tr>
<tr><td colspan="7">Coffee Break (15 minutes)</td></tr>
<tr><td>5-6 p.m.</td><td colspan="2">Poster Session (Corridor, 2nd Floor)</td><td colspan="2">Travel to the Gala Dinner and pictures</td><td colspan="2"></td></tr>
<tr><td>7-9 p.m.</td><td colspan="2">Steering Committee Dinner (by invitation only)</td><td colspan="2">Gala Dinner (all registered participants)</td><td colspan="2"></td></tr>
<tr><td colspan="7"></td></tr>
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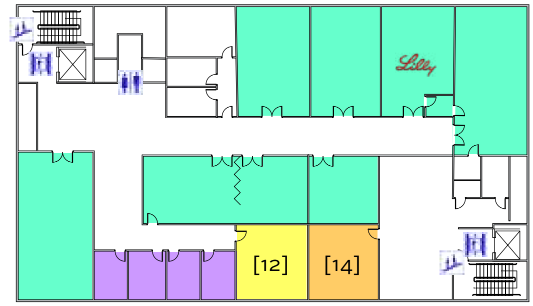
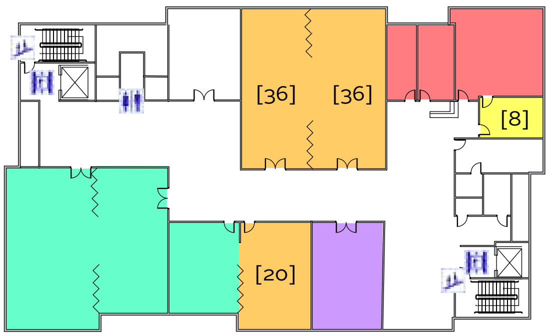
ROOM LOCATION MAP

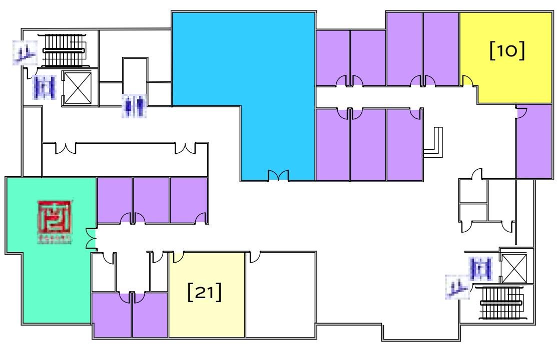
5th Floor



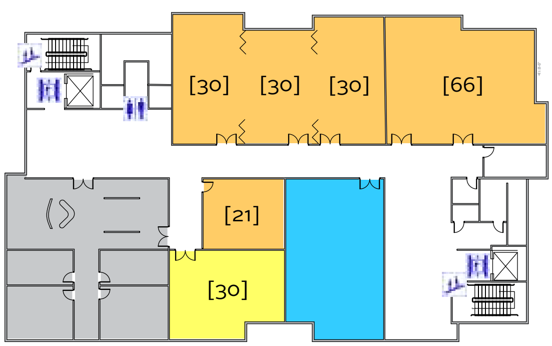
4th Floor



3rd Floor



2nd Floor



1st Floor

Welcome to the University of Dayton China Institute

The University of Dayton China Institute is a convenient and comfortable place to hold training, equipment demonstrations, meetings, and conferences. Audio/visual equipment and catering services are available for any event.

About the Facility

The modern China Institute facility has a total of 6,300 square meters (67,000 square feet) of space which provides the flexibility to meet the needs of your company. The five story building includes:

- 18 seminar and meeting rooms with seating capacities ranging from eight to 90. Projectors are in all rooms, and there is a sound system in larger capacity rooms.
- Videoconference room with a state-of-the-art H.323/ SIP system.
- 12 laboratories for equipment demonstrations, training or research.
- Conference center for exhibits and receptions.
- Innovation center and team rooms for collaborative participant interaction.
- Offices for use by meeting and seminar organizers and faculty.

Contact Us

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- Administrative Office
- Seminar Room
- Conference Room
- Innovation Center
- Laboratory
- Lounge
- Office
- UD History & Heritage Center
- Videoconference
- Elevator
- Restroom
- Stairs

Seating capacity of each seminar room and conference room is shown in brackets [ ]

Day 1 (Morning) – July 4, 2015

Time	Event	Location
8 a.m.-4 p.m.	Registration	Lobby

Opening Ceremony & Plenary I

9-9:30 a.m.	Opening Remarks, Program Committee Chairs

▶ **9:30-10:30 a.m.** Plenary Talk I Professor T.-C. Poon, Virginia Tech University. Room 203

Title: Optical Scanning Holography as an Enabling Technology in Digital Holography (Paper ID I1A02)

Abstract: The celebration of the 2015 International Year of Light (IYL) is in full swing around the globe. The main goal of the IYL is to celebrate and raise awareness of the many uses of light in our lives and the technologies it enables. My presentation on one of the enabling technologies – digital holography, will kick off the celebration of the IYL at the inaugural International Workshop on Thin-Films for Electronics, Electro-Optics, Energy and Sensors in Suzhou, China. In the presentation, I will first give a brief review of the fundamentals of holography. Next, a distinctive digital holographic technique called optical scanning holography (OSH) is discussed. Finally, I will discuss some possible future applications and benefits of OSH.

Notes:

10:30-10:45 a.m. COFFEE BREAK

Morning Sessions

Time	Session	Title	Location
10:45 a.m.-12:15 p.m.	Session 1A	Multifunctional Oxides	Room 201

Chairs: Chonglin Chen, University of Texas at San Antonio, USA, and James Raju, University of Hyderabad, India

10:45-11:15 a.m. Professor Jinn P. Chu, National Taiwan University of Science and Technology, Taiwan (Invited)

Title: Characteristics and Mechanism in Various Amorphous Oxides for Resistance Random Access Memory Application (Paper ID I1A01)

Abstract: Resistance random access memory (RRAM) attracts great interest as a promising candidate for the next generation memory application owing to its high endurance/retention performance, fast write/read access and simple process. The potential candidate materials for the RRAM application are such as amorphous films without forming process. In this study, the first example of oxide is the high thermal stability HoScOx amorphous films with different oxygen contents, prepared by using magnetron sputtering. The 36nm-thick films show the unipolar RS behavior with low operation stresses and no forming required, beneficial for the RRAM device. The RS property is found to vary with the oxygen content in the film, and is thought to be strongly related to the oxygen-deficient (oxygen vacancy) concentration, which serves as the filamentary conduction in the sample in the low resistance state. The second example is multicomponent oxide (MCO) memory device based on an amorphous (ZrCuAlNi)Ox active layer with a thin thickness of ~15nm. The MCO device shows forming-free unipolar RS properties of low operation voltage (<1.7V), long retention time, good endurance and resistance ratio. The RS property is considered to be dominated by the filamentary conduction due to the presence of oxygen vacancies in the grain boundary-free structure.

Notes:

11:15-11:45 a.m. Professor Guoliang Yuan, Nanjing University of Science and Technology, China (Invited)

Title: Flexible Organic Ferroelectric Films with a Large Piezoelectric Response (Paper ID I1B01)

Abstract: Compared with ferroelectric oxides, organic ferroelectric materials are lightweight, flexible and easy to process. They are ideal for applications in the next-generation portable electronics. Here, we demonstrate the room-temperature growth of imidazolium perchlorate ($C_3N_2H_5ClO_4$) ferroelectric films on various substrates, including Pt-coated Si, quartz and, more importantly, on flexible and transparent polyethylene terephthalate (PET). The films have a preferred (0 – 1 – 1) or (1 0 – 1) orientation. The former shows a piezoelectric response comparable with the response of the $Pb(Zr_{0.2}Ti_{0.8})O_3$ film. This is attributed to the smaller elastic constant of the film, which makes it less susceptible to substrate clamping. When grown on PET, the film is transparent and can be bent to radii of a few millimetres without affecting its ferroelectric properties. Our discovery may significantly promote the application of molecular ferroelectrics in flexible and transparent electronics.

Notes:

11:45 a.m.-12:15 p.m. Professor James Raju, University of Hyderabad, India (Invited)

Title: Multifunctionalities with Tunable Dielectric Thin films (Paper ID I1B03)

Abstract: Paraelectric state of ferroelectric thin films and some dielectrics with equivalent sites for ions are known to be useful to make varactors. Examples of both category of materials were grown in thin film form by RF sputtering and PLD process. Thin films of these and related compositions got other functionalities too. Bilayers of them with a magnetic oxide layer makes them a tunable multiferroic system. Resonators made with these films can be used for realizing sensors. Other related interesting phenomena are flourescent quenching in porous $LiNbO_3$ thin films, reduced band gap $BaTiO_3$ and mesocrystalline $BaTiO_3$.

NOTES:

Time	Session	Title	Location
10:45-11:15 a.m.	Session 2	Carbon and Non-Carbon 2D films	Room 203

Chair: Wen Lu, Zhejiang Naboor Power Technology Inc., China

10:45-11:15 a.m. Professor Hongwei Zhu, Tsinghua University, China (Invited)

Title: Graphene-based Solar Cells and Photodetectors (Paper ID I2A01)

Abstract: Graphene has the potential for creating thin film devices, owing to its two-dimensionality and structural flatness. Graphene-on-semiconductor has been proved to be a quality Schottky junction with high photoelectric conversion. Graphene serves multiple functions as transparent electrode, active junction layer, hole collector and anti-reflection layer in the graphene-on-Si heterojunction solar devices. Chemical doping reduces the sheet resistance and increases the work function of graphene, while organic filling of graphene facilitates the hole injection and extraction, resulting in high-quality Schottky junction and enhanced solar conversion performance. Based on the same mechanism, the Schottky junction and photoelectric conversion properties of reduced graphene oxide (RGO)-Si have been further investigated. The ON/OFF ratio, responsivity and detectivity of the RGO/Si photodetectors are closely examined, proving that RGO material could be effectively utilized as the electrode material. By analyzing the response/recovery speed of the RGO-based photodetectors, we have studied the effects of oxygen-containing functional groups and crystalline defects on the photoelectric conversion. It is expected that after complete development, carbon based photovoltaic cells may become more practicable than silicon-based cells by making full use of the above-mentioned advantageous characteristics.

NOTES:

11:15-11:45 a.m. Professor Yong Liu, Wenzhou Medical College, China (Invited)

Title: One-step Synthesis of Polymers Modified Graphene as High-performance Catalysts (Paper ID I2A02)

Abstract: Nitrogen-doped graphene (N-G) has been seen as an effective electrocatalyst recently. The improved catalytic performance for the N-G catalyst was attributed to the electron-accepting ability of the nitrogen atoms, which created net positive charge on adjacent Π-Π conjugated carbon atoms in the carbon plane to readily attract electrons from the anode for facilitating the catalytic process. As such, doping Π-Π conjugated carbon atoms with nitrogen heteroatoms in the nano electrodes can efficiently create active sites for electrochemical catalysis. The demonstration of this new role of nitrogen doping is important and has prompted us to design and develop various novel catalysts for diverse applications such as glucose biosensors and oxygen reduction. In this work, we will demonstrate our recent progress on preparation of polymers functionalized N containing graphene using the novel ball milling technique. Polymers will be incorporated through a ball milling process to prepare well-defined nitrogen-containing conjugated carbon nanostructures. Introduction of the polymer will not only provide electron-acceptor nitrogen, but also provide a highly conducted platform - the Π-Π conjugated carbon plane for efficient transportation of electrons. Combination of N-G and polymers by a facial but efficient way will allow us to develop novel metal free catalysts for various applications both in biosensors and fuel cells.

Notes:

12:15-1:30 p.m. LUNCH BREAK

Day 1, Afternoon Sessions

Time	Session	Title	Location
1:30-3 p.m.	Session 1B	Multi-functional Oxides	Room 201

Chairs: Chonglin Chen, University of Texas at San Antonio, USA, and James Raju, University of Hyderabad, India

1:30-2 p.m. Professor Ramachandra Rao, Indian Institute of Technology, Chennai, India (Invited)

Title: Electronic and Optical Properties of Wide Bandgap Semiconductors (Paper ID I1B02)

Abstract: Wide bandgap semiconductors have attracted considerable interest due to a plethora of applications, including light emitting diodes (LEDs) and displays. Due to large excitonic binding energy (~ 60 meV), and wide bandgap (~ 3.37 eV) nature, ZnO is suitable for many optoelectronic applications[1]. UV-violet emitting p-type ZnO thin films, with phosphorous (P) and nitrogen (N) codoping, have been grown using pulsed laser deposition (PLD). XPS studies show that P is substituted at Zn site, whereas N is substituted at oxygen site. Hall measurements confirmed the p-type nature in co-doped ZnO thin films. I-V characteristics of the heterojunction formed by n-Si and P, N: ZnO showed rectifying nature. Strong violet emission in PL spectra is attributed to the formation of zinc vacancies. We proposed a model based on defect complex, (PZn-VZn-4NO), which acts as an effective acceptor in the P and N codoped ZnO. Another wide bandgap semiconductor, InGaZnO4 (Eg ~ 3.1 eV) is an excellent material for transparent electronics[2]. We study the transport properties of InGaZnO4 (IGZO) thin films grown by PLD. The growth temperature has a great influence on the electron transport of IGZO thin films. Among the oxide semiconductors, tin dioxide (SnO2) based thin film transistors (TFTs) are gaining popularity over other indium (In) based oxide semiconductors owing to the fact that it is a rare element and expensive hence is not suitable for mass production[3]. Phase pure SnO2 films have been deposited using a simple spin coating and annealed at different conditions. Our study mainly focuses on the effect of annealing conditions on the characteristics of TFTs.

References:

1 D. C. Look, Mater. Sci. Eng., B 80, (2001) 383.

2 Kenji Nomura et.al., Appl. Phys. Lett., Vol. 85, No. 11, (2004)

3 Huang G. et.al., ACS Appl. Mater. Interfaces, 6 (23), 20786–20794.

NOTES:

2-2:30 p.m. Professor Haili Bai, Tianjin University, China (Invited)

Title: Interfacial Bond Modified Coupling in Ferromagnetic/multiferroic Heterostructures (Paper ID I1C02)

Abstract: Multiferroic heterostructures based on spinel ferrite and perovskite manganites have recently been the topic of a number of investigations. We fabricated Fe3–*x*V(Ni)*x*O4/BiFeO3 and La0.6Sr0.4MnO3/YMnO3 multiferroic heterostructures by magnetron sputtering. Oxygen vacancies were created in the Fe3–xV(Ni)xO4 films to modify the interfacial coupling. With increasing the concentration of oxygen vacancy, the exchange bias effect of the Fe3–*x*V(Ni)*x*O4/BiFeO3 bilayers was significantly reduced, revealing a weakened interfacial coupling. In the YMnO3 and La0.6Sr0.4MnO3 bilayers, we investigated the crystal orientations and strain effects co-modulated exchange bias effect, and found that the exchange bias effect in the YMnO3/La0.6Sr0.4MnO3 bilayers can be tuned by changing the crystal orientation as a result of the differences in the Mn3+–O–Mn4+ bond angles. Moreover, the strain that supports the formation of antiferromagnetic phase was introduced to the La0.6Sr0.4MnO3 layer when we grew the La0.6Sr0.4MnO3 on YMnO3 layer. Thus an enhanced exchange bias effect was discovered. The results provide a possible route to design the interfacial interaction for multiferroic heterostructures, and are expected to benefit the future magnetoelectric technology.

NOTES:

2:30-3 p.m. Professor Yalin Lu, University of Science and Technology of China (Invited)

Title: A Room-temperature Functional Single-Phase Multiferroic Material (Paper ID I1C03)

Abstract: A single-phase material where ferroelectricity and ferromagnetism coexist at room temperature (RT) is hardly available at present, and it is even more rare for such a material to further have an intrinsic and low magnetic field response magnetoelectric (ME) coupling at temperatures higher than RT. In this talk, a new single-phase Aurivillius compound, $SrBi_5Fe_{0.5}Co_{0.5}Ti_4O_{18}$ has been introduced that exhibits a plausible intrinsic ME coupling. Remarkably, this property appears at a high temperature of 100°C, surpassing all single-phase multiferroic materials currently under investigation. With a magnetocapacitance effect detectable at 100°C and under a low response magnetic field, a RT functioning device was demonstrated to convert an external magnetic field variation directly into an electric voltage output. The availability of such a single-phase material with an intrinsic and low magnetic field response that is multiferroic at high temperature is important to the fundamental understanding of physics and to potential applications in sensing, memory devices, quantum control, etc.

NOTES:

Time	Session	Title	Location
1:30-3 p.m.	Session 3A	Thin film Microelectronics	Room 203

Chairs: Nian Sun, Northeastern University, USA, and Ming Liu, Xian Jia Tong University

1:30-2 p.m. Professor Ying-Hao Chu, National Chiao Tung University, Taiwan (Invited)

Title: An Approach of Heteroepitaxy to Understand Photoelectrochemistry Across Complex Oxide Interface (Paper ID I3A01)

Abstract: Complex oxides are materials that cover a broad spectrum of intriguing functionalities due to the interplays among degrees of freedom. Recently, complex oxide nanocrystals performed their remarkable optical, electronic, mechanical, thermal, magnetic, and quantum paraelectric properties. Because of these properties, they are extensively exploited in technological applications like ferrofluid, biomedicine, and recording media. For complex oxide thin films, the heteroepitaxy provides a powerful route to manipulate their lattice, charge, orbit, and spin degrees of freedom to enhance the functionalities. However, so far, there is no platform to understand photoelectrochemistry of complex oxide heterostructures. In this talk, several examples will be given based on the concept of epitaxy, which provides a control of crystal facets. For example, the enhanced photoactivity of plasmonic semiconductor photocatalysts with particular crystal facet has shed light on the design of highly efficient photocatalyst platform. In this talk, we utilized Au or WO_3-decorated $BiVO_4$ (BVO), in which BVO thin film with exposed {001} facets was decorated with Au nanoparticles (NPs) or WO_3 nanopillars with various sizes and densities, as a model photocatalyst for realizing the plasmonic photocatalysis. The Au/BVO and WO_3/BVO heterostructures exhibited significantly enhanced photoactivities in both dye degradation and electrolytic water splitting. The results of 3D finite-difference time domain simulation showed a strong electrical field amplification for Au/BVO in the visible region, ascribable to the SPR excitation of the decorated Au. The energy band alignment and electronic relaxation dynamics of Au/BVO heterostructures suggested that the improved interfacial electron transfer from BVO to Au was responsible for the enhanced photoactivity of Au/BVO. The same concept will be applied to other complex oxide systems as well, such as $BiFeO_3$, $SrTiO_3$, and $NiWO_4$. This talk delivers a general approach to probe the photochemistry of complex oxide heterostructures for photoconversion applications.

NOTES:

2-2:30 p.m. Professor Kaikai Xu, University of Electronic Science and Technology of China (Invited)

Title: Light Emission in Silicon: From Device Physics to Applications (Paper ID I3B02)

Abstract: Silicon photonics is an emerging field of research and technology, where nano-silicon can play a fundamental role. Visible light emitted from reverse-biased p-n junctions at highly localized regions, where avalanche breakdown occurs, can be used to realize visible electro-optical sources in silicon by means of light-emitting diodes (Si-LEDs) is reviewed by characterizing the spectral distribution. Regarding applications, a monolithic optoelectronic integrated circuit (OEIC) for on-chip optical interconnection based on standard CMOS technology is discussed. Although there are some of the present challenges with regard to the realization of suitable electro-optical elements for diverse integrated circuit applications, the type of silicon light source can be further developed into being a Si-based optically controlled power switch for high-temperature and high-power applications.

Notes:

2:30-3 p.m. Professor Siyang Liu, Southeast University (Invited)

Title: Opportunities for Employing Power IGBT Photoswitch Based on Si Avalanche LEDs (Paper ID I3B03)

Abstract: Research activities are described with regard to the development of a comprehensive approach for the practical realization of silicon light-emitting devices (Si-LEDs) with emitting visible light in the 400 to 900 nm wavelength region. Prototype Si-LEDs are fabricated in the standard CMOS technology, using the same masks and processing procedures with other components. Since fully integrated silicon photon-receivers with Si-LED on the same chip will largely improve the overall system performance, monolithic integration leads to lower cost and smaller size. In this work some structural details of several practical two terminal and multi terminal Si-LEDs are designed and realized by us, as well as experimental results describing their performance are presented. In this paper, we report on further progresses that have been made with regard to modeling of the physical processes in realizing increase in the optical emission power, as well with regard to higher frequency modulation capability of such device. The theory of silicon optical modulation based on p-n junction in reverse bias is primarily discussed. Initial investigations indicate that the Si-LEDs have a very fast inherent modulation bandwidth capability, and the upper limit derived value for the expected maximum modulation of the device could be in the range of a few hundred GHz. According to the best of our knowledge, despite the low efficiency, the Si-LEDs show potential for on-chip electro-optical communication and chip-to-chip electro-optical communications.

Notes:

3-3:15 p.m. COFFEE BREAK

Time	Session	Title	Location
3:15-4:15 p.m.	Session 1C	Multi-functional Oxides	Room 201

Chairs: Chonglin Chen, University of Texas at San Antonio, USA, and James Raju, University of Hyderabad, India

3:15-3:45 p.m. Professor Vinay Gupta, University of Delhi, India (Invited)

Title: Multiferroic Thin Films and Multilayer Structures for Energy Harvesting Applications (Paper ID I1D01)

Abstract: Recently multifunctional properties of multiferroic materials have attracted researchers worldwide and provided a solution to the problem of energy crises. To overcome the energy crisis, materials having band gap in visible region along with excellent ferroelectric properties are of current requirement for photovoltaic applications. $BiFeO_3$ is a very well known multiferroic material having small energy gap (2.5 eV) and promising multiferroic properties that can offer potential application in both optoelectronics and solar energy devices towards abundant renewable clean energy harvesting. The major disadvantage of $BiFeO_3$ films are high leakage current that can be taken care-of by material engineering. The (Ce, Mn) codoped $BiFeO_3$ (BCFMO) thin films grown on low cost ITO coated glass substrates have been investigated. It has been observed that, the transient response of photovoltaic current of the BCFMO thin film in metal-multiferroic-metal (MMM) configuration is strongly dependent on both the intensity of incident light ($\lambda = 405$ nm) from 15 to 160 mW/cm^2 and thickness of BCFMO film. Current voltage measurement shows an increase in photoinduced open circuit voltage and short circuit photocurrent with increase in intensity of illuminating light. An enhancement of about 240 fold in photo-induced current has been observed in 110 nm thin BCFMO film. Further, multilayer structures of BFMO/BCFO and BFO/BTO have also been grown by pulsed laser deposition (PLD) technique. The effect of variation in constituent layers in the multilayered structure on structural, electrical and ferroelectric properties has been explored. A larger remnant polarization ($2P_r$-114$\mu C/cm^2$) due to reduced leakage current density of $1.1\times10^{-7} A/cm^2$ has been measured at an applied voltage of 5V for the BFMO/BCMO multilayered structure. Another field in energy harvesting is based on the conversion of mechanical vibrations into electrical power. Piezoelectric cantilever plays crucial role in converting the vibrations into an electrical output which can be used to harvest energy. Cantilever was fabricated by depositing the single-phase piezoelectric thin film on a foil using chemical deposition technique. Platinum inter digital electrodes were patterned over the cantilever in order to get the electrical contacts. The cantilever was tested using Laser Doppler Vibrometer and a micro shaker. The shift in resonant frequency has been observed with varying the tip mass. The effect of acceleration on the cantilever was also studied to get the enhanced output. Results obtained from fabricated cantilever are promising and provide sufficient output voltage for realization of efficient energy harvesters.

NOTES:

3:45-4:15 p.m. Professor Chonglin Chen, University of Texas at San Antonio, USA (Invited)

Title: Ultrafast Atomic Layer-by-Layer Oxygen Vacancy-Exchange Diffusion in Double-Perovskite $LnBaCo_2O_{5.5-d}$ Thin Films (Paper ID I1D03)

Abstract: Surface exchange and oxygen vacancy diffusion dynamics were studied in double-perovskites $LnBaCo_2O_{5.5+d}$ (LnBCO) single-crystalline thin films (Ln = Er, Pr; 0.0 < d < 0.5) by carefully monitoring the resistance changes under a switching flow of oxidizing gas (O_2) and reducing gas (H_2) in the temperature range of 250~800°C. A giant resistance change DR by three to four orders of magnitude in less than 0.1 s was found with a fast oscillation behavior in the resistance change rates in the DR vs. t plots, suggesting that the oxygen vacancy exchange diffusion with oxygen/hydrogen atoms in the LnBCO thin films is taking the layer by layer oxygen-vacancy-exchange mechanism. The first principles density functional theory calculations indicate that hydrogen atoms are present in LnBCO as bound to oxygen forming O-H bonds. This unprecedented oscillation phenomenon provides the first direct experimental evidence of the layer by layer oxygen vacancy exchange diffusion mechanism. This new finding paves a new avenue for cathode materials operating in low-temperature solid-oxide-fuel-cell devices and chemical sensors with a wide range of operating temperature.

NOTES:

Time	Session	Title	Location
3:15-4:15 p.m.	Session 3B	Thin Film Microelectronics	Room 203

Chairs: Nian Sun, Northeastern University, USA, and Kaikai Xu, University of Electronic Science and Technology of China

3:15-3:45 p.m. Professor Lei Bi, University of Electronic Science and Technology of China (Invited)

Title: Integrated Nonreciprocal Photonic Devices Using Magneto-optical Oxide Thin Films (Paper ID I3C01)

Abstract: Nonreciprocal photonic devices provide important functionalities to photonic systems such as optical isolation and circulation. Achieving optical nonreciprocity in semiconductor integrated photonic circuits has been a long term challenge. In this paper, I will review our recent progress of integrating magneto-optical oxide thin films, specifically, magnetic garnet thin films on silicon substrates for nonreciprocal photonic device applications. Phase pure yttrium iron garnet with room temperature saturation magnetization of 140 emu/cm^3 has been grown on silicon using pulsed laser deposition in a wide fabrication process window. Using such materials as seed layers, we demonstrate phase pure $Ce_{1.3}Y_{1.7}Fe_5O_{12}$ thin films grown on silicon, featuring more than two times higher Kerr rotation at 635 nm wavelength than our previously reported $Ce_1Y_2Fe_5O_{12}$ thin films. By using first principle calculations, we demonstrate that both oxygen vacancies and strain can significantly influence the valence state of Ce, as well as the magneto-optical and optical properties of these materials. A broad band strip optical isolator is designed using the CeYIG/SOI vertical MMI structure. The device is less than 1 mm long, showing a high isolation ratio of 20 dB and low insertion loss of less than 2 dB around 1550 nm wavelength.

NOTES:

3:45-4:15 p.m. Professor Ming Liu, Xi'an Jiao Tong University, China (Invited)

Title: Electrically Non-Volatile Switching of Magnetism for Reconfigurable Microwave and Electronic Devices (Paper ID I3D02)

Abstract: The central challenge in tunable magnetic microwave devices lies in finding an energy efficient way to perform wide range ferromagnetic resonance (FMR) voltage tuning in a reversible and reproducible manner, rather than with a current-driven electromagnet.[1] Multiferroic heterostructures, exhibiting a strong strain-mediated magnetoelectric (ME) coupling between distinct ferromagnetic and ferroelectric phases, have shown great promise for frequency agile microwave applications. In these materials, a single control parameter of *in situ* voltage-induced piezo-strain, arising from ferroelectrics, is used to shift FMR frequency in elastically-coupled ferromagnetic phases via magnetoelastic effects.[2, 3] Therefore, devices based upon such materials are, in principle, light-weight, fast, and energy efficient, overcoming some of the intrinsic limitations in conventional microwave components, while providing new functionality. However, in most prototype ME microwave devices, tuning of FMR frequency has been achieved through the use of a linear piezo response.[4, 5] Upon removing the electric field, the FMR decays to the initial state. While these devices point towards a unique pathway for enhancing FMR tunability, reversible and non-volatile tuning of FMR using strain has remained relatively unexplored, and this is indispensable from a device application point of view. In this presentation, we will demonstrate three approaches to realizing non-volatile tuning FMR in microwave magnetoelectric composites. They are including 1) Ferroelastic domain dynamic switching in (011) oriented PMN-PT ($0.71Pb(Mg_{1/3}Nb_{2/3})O_3$-$0.29PbTiO_3$) single crystal, that allows polarization vectors to rotate from an out-of-plane to a purely in-plane direction, thereby producing two distinct, stable and reversible lattice strain states. Voltage-impulse-induced non-volatile tuning of FMR can be realized in FeCoB/PMN-PT (011) through dynamic switching between these two distinct strain states. 2) Voltage induced 109° ferroelastic polarization switching in (001) oriented PZN-PT ($0.93Pb(Zn_{1/3}Nb_{2/3})O_3$-$0.07PbTiO_3$) single crystal, that enables distinct lattice strain states in the in-plane diagonal directions ([110] or [1-10]), thereby results in the modulation of FMR in a stable and reproducible manner in FeGaB/PZN-PT (001) heterostructures.[6] 3) Voltage-induced hysteretic phase transition in (011) oriented PZN-PT single crystal enables two reversible rhombohedral and orthorhombic stain states. Switching between these two states stimulated by voltage impulse, the FMR can be tuned non-volatilely in FeGaB/PZN-PT (011) heterostructures.[5] These results point to opportunities for electrical tuning of strain sensitive properties in all materials and provide a framework for realizing reconfigurable, frequency agile, non-volatile and energy efficient electronics and microwave devices.

References:

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2 C. W. Nan, M. I. Bichurin, S. X. Dong, D. Viehland, G. Srinivasan, Journal of Applied Physics 2008, 103.

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4 M. Liu, J. Lou, S. D. Li, N. X. Sun, Adv. Funct. Mater. 2011, 21, 2593.

5 M. Liu, Z. Zhou, T. Nan, B. M. Howe, G. J. Brown, N. X. Sun, Adv. Mater. 2013, 25, 1435.

6 M. Liu, B. M. Howe, L. Grazulis, K. Mahalingam, T. Nan, N. X. Sun, G. J. Brown, Adv. Mater. 2013, 25, 28.

Notes:

4:15-4:30 p.m. COFFEE BREAK

Accepted Poster Papers

1. **Title: Pulse Propagation in PZT Thin Film with Gold Micro-discs** Reema Gupta1, Monika Tomar2, Vinay Gupta1 and Satchi Kumari1* 1Department of Physics & Astrophysics, University of Delhi, Delhi, India. 2Physics Department, Miranda House, University of Delhi, Delhi, India *Email: satchikumarisingh@gmail.com (Paper P1-01)
2. **Title: LTA Zeolite-metal Oxide Based Carbon Monoxide Gas Sensor Avneet Singh1, Hanan Mir2, Rudra Chaudhary2, Anjali Sharma3, Monika Tomar3, Vinay Gupta1*** 1Department of Physics and Astrophysics, University of Delhi, Delhi 110007, India 2Amity Institute of Nanotechnology, Amity University, Uttar Pradesh 201313, India 3Physics Department, Miranda House, University of Delhi, Delhi-110007, India *Email: drguptavinay@gmail.com (Paper P1-02)
3. **Title: Fabrication of Surface Acoustic Wave Devices for UV Sensing Lokesh Rana1, Reema Gupta1, Monika Tomar2, Vinay Gupta1*** 1Department of Physics and Astrophysics, University of Delhi, Delhi, India 2Physics Department, Miranda House, University of Delhi, Delhi, India *Email ID: drguptavinay@gmail.com (Paper P1-03)
4. **Title: Optical Tuning of Electrical Properties of PZT Thin Film Deposited on STO Reema Gupta1, Monika Tomar2, Vinay Gupta1*** 1Department of Physics and Astrophysics, University of Delhi, Delhi, India 2Physics Department, Miranda House, University of Delhi, Delhi, India *Email: drguptavinay@gmail.com (Paper P1-04)
5. **Title: Nanostructured Zinc Oxide Thin Film For Application to Surface Plasmon Resonance Based Cholestrol Biosensor Gurpreet Kaur1, Monika Tomar2, Vinay Gupta1,a** 1Department of Physics and Astrophysics, University of Delhi, Delhi 110007, India 2Physics Department, Miranda House, University of Delhi, Delhi 110007, India aCorresponding author Email: drguptavinay@gmail.com (Paper P1-05)
6. **Title: Study on Transmission Volume-phase Holographic Grating Recorded on Dichromated Gelatin Film Used in Raman Spectrometer** Qijing Mei1,2 Peng liu1,2, Xizhao Zhang1,2 and Minxue Tang* 1,2College of Physics, Optoelectronics and Energy of Soochow University, Soochow 215006, Jiangsu Province, China email: mxtang@suda.edu.cn (Paper P1-06)
7. **Title: Direct Metal Transfer Printing on Flexible Substrate for Fabricating Optics Functional Devices** Yingjie JIANG, Xiaohong ZHOU*, Linsen CHEN, Changsi Peng*i College of Physics, Optoelectronics and Energy, Soochow University, Suzhou, 215006, China Corresponding authors: 20134239023@stu.suda.edu.cn, xhzhou@suda.edu.cn, changsipeng@suda.edu.cn (Paper P1-07)
8. **Title: Both Improvement of the Light Extraction Efficiency and Emergence Angle of GaN-LED Using Sub-micron Fresnel Lens Array** Xinyu Gu, Linsen Chen*, Su Shen*, Wenqiang Wang College of Physics, Optoelectronics and Energy of Soochow University, Soochow 215006, Jiangsu Province, P.R.China email: lschen@suda.edu.cn (Paper P1-08)
9. **Title: High Order Aspheric Optical Compensation System Research** Donghui Shen, Bin Xie*, Liang Zong College of Physics, Optoelectronics and Energy of Soochow University, Soochow 215006, Jiangsu Province, P.R.China email: xiebin@suda.edu.cn (Paper P1-09)
10. **Title: Method for the Measurement of Surface-relief Grating's Profile Using Initial Phase of Diffraction Wave** Fanrong Feng, Jianhong Wu*, Fei Gao College of Physics, Optoelectronics and Energy of Soochow University, Soochow 215006, Jiangsu Province, China (Paper P1-10)
11. **Title: Study on Hydrophobic Properties and Fabrication of Two-dimensional Grating on Fluorine-containing Azobenzene Polymer Film** Jian Wang, Jianhong Wu*, Lixiong Xu College of Physics, Optoelectronics and Energy of Soochow University, Soochow 215006, Jiangsu Province, P.R.China email: jhwu@suda.edu.cn (Paper P1-11)
12. **Title: Wavefront Reconstruction Using Smartphone Based Wavefront Sensors** Zhenyu Yang*, Qiwen Zhan University of Dayton, 300 College Park, Dayton, OH 45469, USA. Email: yangz2@udayton.edu (Paper P1-12)
13. **Title: Research on Multi-source Datas Integration and the Extraction of Three-dimensional Displacement Field Based on GBSAR** Yue Shun1, J P Yue1, Qiu Zhiwei1, Wang Xueqin1, Guo Leping1, School of Earth Science and Engineering, Hohai University, Nanjing, 210098, China email: yue_shun@163.com (Paper P1-13)
14. **Title: A Review of Atmospheric Disturbance Correction in GBInSAR** WANG Xueqin1, YUE Jianpin1, QIU Zhiwei1, YUE Shun1 Earth Science and Engineering of Hohai University, Nanjin, Jiangsu 210098, China email: wxqstay@163.com (Paper P1-14)
15. **Title: Tunable Microwave Phase Shifters Using Thin Film Varactors** Hailing Yue, Devin Spatz, Shu Wang, Eunsung Shing, and Guru Subramanyam CETRASE, Department of Electrical and Computer Engineering, University of Dayton, Dayton, OH 45469-0232, USA. Email: yueh01@udayton.edu (Paper P1-15)
16. **Title: Modeling Techniques Applied to High K Dielectric Thin Film-based Resonant Circuits** Shu Wang, Eunsung Shin, Weisong Wang and Guru Subramanyam, CETRASE, Department of Electrical and Computer Engineering, University of Dayton, Dayton, OH 45469-0232, USA. Email: wangs3@udayton.edu (Paper P1-16)

Day 2 (Morning) – Sunday, July 5, 2015

Time	Event	Location
8 a.m.-4 p.m.	Registration	Lobby
9-10:30 a.m.	**Plenary Session II**	**Room 203**

9-9:45 a.m. Plenary Talk 1 Professor Chung Kun Song, Dong-A University, Busan, S. Korea (Invited Plenary Speaker)

Title: Thin Films for Flexible AMOLED Displays Driven by OTFTs (Paper ID I4B01)

Abstract: Active matrix organic light emitting diode (AMOLED) displays are attracting much attention as a future display due to the unique properties such as self-emission and the excellent compatibility to flexible substrates. In this presentation, we will review our recent works of AMOLED displays on flexible substrates. Especially, we emphasize on fabrication processes of organic thin film transistors (OTFTs) and OLEDs, including printing processes, by using the various organic materials and the conductive inks. We will also discuss the integration of fabrication processes of OTFTs and OLEDs to implement AMOLED displays, and demonstrate the operation of flexible AMOLED displays on a plastic and a fabric substrate.

Notes:

9:45-10:30 a.m. Plenary Talk 2 Professor Nian Xian Sun, Northeastern University, Boston, USA (Invited Plenary Speaker)

Title: Integrated Multiferroics for Compact and Power Efficient Sensing, Memory, RF and Microwave Electronics (Paper ID I3B01)

Abstract: The coexistence of electric polarization and magnetization in multiferroic materials provides great opportunities for realizing magnetoelectric coupling, including electric field control of magnetism, or vice versa, through a strain mediated magnetoelectric coupling in layered magnetic/ferroelectric multiferroic heterostructures [1-8]. Strong magnetoelectric coupling has been the enabling factor for different multiferroic devices, which however has been elusive, particularly at RF/microwave frequencies. In this presentation, I will cover the most recent progress on new integrated multiferroic devices for sensing, memory, RF and microwave electronics, including novel RF NEMS magnetoelectric resonators with picoTesla sensitivity for DC magnetic fields, and novel GHz magnetic and multiferroic inductors with a wide operation frequency range of 0.3~3GHz, and a high quality factor of close to 20, and a voltage tunable inductance of 50%~150%. At the same time, we will demonstrate other voltage tunable multiferroic devices, including voltage tunable multiferroic bandpass filters, tunable bandstop filters, tunable phase shifters, magnetoelectric random access memory, etc. These novel integrated multiferroic devices show great promise for applications compact, lightweight and power efficient sensing, memory, RF and microwave integrated electronics.

References:

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Notes:

10:30-10:45 a.m. COFFEE BREAK

Morning Sessions

Time	Session	Title	Location
10:45 a.m.- 12:15 p.m.	Session 4	Flexible and Printable Electronics	Room 201

Chair: Professor Chunkun Song, Dong-A University, S. Korea

10:45-11:15 a.m. Professor Yong-Young Noh, Dong Guk University, S. Korea (Invited)

Title: Development of Printed Ambipolar Polymer Complementary Integrated Circuits (Paper ID I4A01)

Abstract: Ambipolar π-conjugated polymers may provide inexpensive large-area manufacturing of complementary integrated circuits (CICs) without requiring micro-patterning of the individual p- and n-channel semiconductors. However, current-generation ambipolar semiconductor-based CICs suffer from higher static power consumption, low operation frequencies, and degraded noise margins compared to complementary logic based on unipolar p- and n-channel organic field-effect transistors (OFETs). Here we demonstrate a simple methodology to control charge injection in ambipolar OFETs via engineering of the electrical contacts. By controlling the electrode surface chemistry, excellent p-channel (hole mobility ~ 0.1 – 3 cm^2/Vs) and n-channel (electron mobility ~ 0.1 – 2 cm^2/Vs) OFET characteristics with various state-of-art conjugated polymers are demonstrated. Most importantly, in these OFETs the counterpart charge carrier currents are highly suppressed for depletion mode operation (I_{off} < 70 nA when I_{on} > 150 – 200 μA). Thus, high-performance, truly complementary inverters (gain > 50) and ring oscillators (oscillation frequency 10 ~ 50 KHz) based on a solution-processed ambipolar polymer are demonstrated for the first time. In addition, various logic circuits such as NAND, NOR, and XOR etc. were demonstrated by optimizing gate dielectrics, printing processes, and contact resistance optimization.

NOTES:

11:15-11:45 a.m. Professor Jun Takeya, Tokyo University, Japan (Invited)

Title: Materials and Devices of High-performance Organic Transistors for Printed Circuits (Paper ID I4A02)

Abstract: This presentation focuses on recent development of key technologies for printed LSIs which can provide future low-cost platforms for RFID tags, AD converters, data processors, and sensing circuitries. Such prospect bears increasing reality because of recent research innovations in the field of material chemistry, charge transport physics, and solution processes of printable organic semiconductors. Achieving band transport in state-of-the-art printable organic semiconductors, carrier mobility is elevated above 15 cm^2/Vs, so that reasonable speed in moderately integrated logic circuits can be available. With excellent chemical and thermal stability for such compounds, we are developing simple integrated devices based on CMOS using p-type and n-type printed organic FETs. Particularly important are new processing technologies for continuous growth of inch-size organic single-crystalline semiconductor "wafers" from solution[1] and for lithographical patterning of semiconductors and metal electrodes[2]. Successful rectification and identification are demonstrated at 13.56 MHz with printed organic CMOS circuits for the first time.

NOTES:

11:45 a.m.-12:15 p.m. Professor Baoquan Sun, Soochow University, China (Invited)

Title: Organic-Silicon Photovoltaic with High Performance (Paper ID I4B02)

Abstract: Organic-inorganic hybrid solar cells based on nanostructured semiconductor have built up in few years ago, which may promise the low cost and high performance. However, the device performances are relatively lower than its pristine all-inorganic PV devices, resulting from the numerous surface defect and improper organic-inorganic phase segregation. In our group, we have developed various nanostructured semiconductors for high-performance solar cell. Here, we demonstrate that hybrid PVs based on organic conjugated molecular and nanostructured silicon nanowire (Nano-Si) arrays can achieve a high PCE (~14%) by controlling the phase separation as well as surface passivation.

NOTES:

Time	Session	Title	Location
10:45-12:15 p.m.	Session 5	Thin-film Meta Materials	Room 203

Chair: Partha Banerjee, CETRASE, University of Dayton, USA

10:45-11:15 a.m. Professor Lei Zhou, Fudan University, China (Invited)

Title: Recent Advances on Metasurfaces (Paper ID I5A02)

Abstract: Metamaterials are artificially engineered materials whose optical properties arise primarily from their micro-structure ("meta-atom") and their macroscopic order. Metasurface, as a new emerging field of metamaterials, has aroused considerable interest due to their capability of arbitrary manipulation of the phase and amplitude profile at the interface. In this talk, we briefly summarize our latest experimental results on employing metasurfaces to control electromagnetic waves. Specifically, we will show how to realize a photonic spin-Hall effect with nearly 100% efficiency [1], how to achieve a surface-plasmon coupler that can excite surface plasmon polaritons (SPPs) very efficiently [2], and how to actively control the phases of electromagnetic waves with graphene-based metasurfaces [3].

References:

1 Weijie Luo, *et al*., "Photonic spin hall effect with nearly 100% efficiency ," Adv. Opt. Mater., DOI: 10.1002/ adom.201500068

2 Wujiong Sun, *et al*., "High-efficiency surface plasmon couplers based on transparent gradient metasurfaces", under review.

3 Ziqi Miao, *et al*., "Widely tunable terahertz phase modulation with gate-controlled graphene metasurfaces", under review.

NOTES:

11:15-11:45 a.m. Dr. Chenglong Zhao, National Institute for Standards and Technology, USA (Invited)

Title: Nanoscale Light Manipulation with Plasmonic Nanostructures on Thin Films (Paper ID I5A03)

Abstract: In the last decade, there has been a revolution in optics that benefits from the deep understanding of the light-matter interaction at nanoscales. Now, we can break the fundamental diffraction limit in optics by utilizing the so-called plasmonic effect on metallic nanostructures. We can even create optical materials that does not exist in nature, for example, the metamaterials can have negative refractive index. Therefore, the ability of controlling light at nanoscales gives us a new way of looking at the engineer problems in optics and allows us to design novel optical devices with functionalities that cannot be realized by using conventional diffraction-limited optics. In this talk, I will first show how we can control two-dimensional (2D) light with rationally designed nanostructures. Then I will show how we can control nanoscale light for detecting single molecules in solutions at high concentrations.

Notes:

11:45 a.m.-12:15 p.m. Professor Partha Banerjee, University of Dayton, USA (Invited)

Title: Second Harmonic Generation for Oblique Incidence of Fundamental in Nonlinear Multilayer Photonic Bandgap Structures (Paper ID I5B01)

Abstract: Under phase-matching condition, second harmonic generation (SHG) generated by oblique incidence fundamental wave (FW) in nonlinear photonic bandgap structures (PBG) is analyzed by transfer matrix method (TMM). Multiple reflection and interference effects are taken into account while deriving the TMM for both transverse-electric (TE) polarized fundamental and SH wave. The radiation of fundamental and SH waves from both sides of a nonlinear optical sample and the distribution of their fields within the structure are discussed. Under pump nondepletion assumption, the conversion efficiencies of SH wave versus different incident angles of FW are studied in detail.

Notes:

12:15- 1:30 p.m. LUNCH BREAK

Day 2, Afternoon Sessions

Time	Session	Title	Location
1:30-3 p.m.	Session 8A	Organic and Biological Thin Films	Room 201

Chair: Professor Wen Li, Michigan State University, USA

1:30-2 p.m. Professor Jin-Quan Liu, Shanghai Jiao Tong University, China (Invited)

Title: Flexible MEMS Implantable Neural Interface Devices Based on Parylene Film (Paper ID I8A01)

Abstract: With the development of medical electronic devices, implantable devices based on flexible MEMS have achieved rapid development. The body environment is extreme, so the implanted devices not only have good biocompatibility, but also withstand the erosion of various enzymes in the body. Parylene film has good biocompatibility and biological inertness, which is issued by FDA and belongs to USP VI materials for the permanent implantable materials. This presentation is related to flexible MEMS implantable neural interface device based on Parylene film. First of all, the nano-particles were used to modify the Parylene C thin film, which could help to improve the Parylene C properties of heat-resistant and UV-resistant.Then, the microelectrode array and tubular microelectrode were introduced for the flexible MEMS neural interface. In order to reduce the interface impedance between the electrode and the tissue, the platinum black, iridium oxide and PEDOT/GO composite were adopted as the surface modification materials. Furthermore, the flexible MEMS implantable neural interface devices were implanted into the animal to verify the function for the paralysis rehabilitation and biorobot.

Notes:

2-2:30 p.m. Professor Honglong Chang, Northwestern Polytechnical University, China (Invited)

Title: A Miniature Ion Chromatography System for Water Quality Monitoring (Paper ID I8A02)

Abstract: Monitoring water composition has become an area of intense interest for scientists since the water pollution become more and more severe. High performance liquid chromatography (HPLC) is one of the most powerful and widely used separation techniques with the capability of separation and/or quantification of the chemical compounds in complex mixtures. We have developed an integrated ion liquid chromatography chip, which consists of electrochemical pumps, 6-way valve, separation column, and contactless conductivity detector. Sample handling and detection of anions in water have been successfully demonstrated.

Notes:

2:30-3 p.m. Professor Siyang Zheng, Penn State University, USA (Invited)

Title: Thin Film Integrated Micro/nano Devices for Bio-applications (Paper ID I8A03)

Abstract: Micro/nano devices have wide bio-applications including pathogen detection, disease diagnosis and treatment, environmental monitoring. In some cases, integrated thin films are the key material and provide pivotal functions to the device. In this talk, I will discuss some examples from my research group. For example, recently we developed a flexible micro spring array (FMSA) device to enrich circulating tumor cells (CTC) from blood samples of metastatic cancer patients. The thin film polymer material and device design provide the crucial mechanical and structural properties for the high performance of the device. In another example, we demonstrated integration of a thin film polymer with high glass transition temperature as a MEMS high temperature flow controller. The device can operate inside a gas chromatography (GC) oven above 300°C to enable various GC applications.

NOTES:

Time	Session	Title	Location
1:30-3 p.m.	Session 6	Optics at the Surface	Room 203

Chair: Qiwen Zhan, CETRASE, University of Dayton, USA

1:30-2 p.m. Professor Guanghao Rui, Southeast University, China (Invited)

Title: Steerable Beaming of Photons with Angular Momentum Using Nano-Emitter Coupled Plasmonic Structure (Paper ID I6A01)

Abstract: Controlling the emission characteristics from nanoscale quantum emitters is key to a wide range of applications. Recent rapid advances in optical antenna offer tremendous opportunities to implement such controls. A comprehensive control (including intensity, directivity, polarization, angular momentum as well as direction) of the photons emitted from nanoscale emitters would be extremely attractive for many applications ranging from single molecular sensing to spin optics and quantum information processing. Such a holistic control has been successfully demonstrated with a technique we recently developed through coupling the emitters to a miniature spiral plasmonic slot antenna.

NOTES:

2-2:30 p.m. Professor Thomas Haertling, Fraunhofer Institute, Dresden, Germany (Invited)

Title: Optical Nanosensor Technology — From Basic Research to Industrial Applications (Paper ID I6A02)

Abstract: Optically active nanomaterials enable exciting novel applications of optical measurement technology such as gas sensing with nanoscale infrared antennas, dosimetry with ceramic phosphors, or molecular sensing and detection by means of nanostructured surfaces in general, to name a few only. Some techniques are still in their infancy, while others already led to industrially relevant applications. This contribution intentionally illustrates both ends of the readiness level scale to provide an idea of the bandwidth currently found in this field of research. On the one hand, surface-enhanced infrared spectroscopy and the fabrication of the necessary infrared nanoantennas as pursued in the group of the authors is described to give an example of an extremely promising, yet not market-ready optical nanosensor technology. On the other hand, the use of nanoscale ceramic phosphors for radiation dose measurements is presented as a technique with a high technology readiness level and economically relevant application scenarios.

NOTES:

2:30-2:50 p.m. Dr. Yadong Xu, Soochow University, China (Contributed)

Title: Thin Films of Plasmonic Materials to Control Transverse Magnetic Modes in a Waveguide (Paper ID C6B01)

Abstract: In a parallel-plated waveguide, the transmission properties of transverse electric (TE) and transverse magnetic (TM) polarized wave differ, due to different responses of magnetic field and electric field to the outer metallic boundaries. One well-known feature is that there is a cut-off frequency for TE wave, but none for TM wave. Here, we show that when two layers of plasmonic materials are attached to the metal walls of the waveguide, a band gap, resulted from the interaction of excited surface plasmon polaritons, will emerge for TM mode. With the plasmonic materials becoming thin enough, a critical thickness can be found. For the width larger than the critical value, the band gap is fixed, otherwise a tunable band gap can be achieved, i.e., different widths induce different band gaps.

NOTES:

3-3:15 p.m. COFFEE BREAK

Time	Session	Title	Location
3:15- 4:45 p.m.	Session 8B	Organic and Biological Thin Films	Room 201

Chairs: Professor Jinquan Liu, Shanghai Jiao Tong University, USA and Honglong Wang, Northwestern Polytechnical University, China

3:15-3:45 p.m. Professor Wen Li, Michigan State University, USA (Invited)

Title: Polycrystalline Diamond-Based MEMS Devices for Biological and Chemical Sensing (Paper ID I8B01)

Abstract: This paper reviews our recent progress in the development of polycrystalline diamond (PCD) micro-electro-mechanical-systems (MEMS) devices for applications in biological and chemical sensing. In particular, we have designed and implemented a hybrid optoelectronic neural interface optrode, which combines micro-scale light emitting diode (μLED) and microelectrodes on a PCD substrate for optogenetic stimulation and electrical recording of neural activity in deep cortical regions [1]. Utilizing the excellent thermal conductivity (up to 1800 Wm-1K -1) of PCD, this device allows rapid dissipation of localized LED heat to surrounding perfused tissues, and thus significantly reduces the risk of thermal damage to nerve tissue. In addition, recently we developed a flexible, hybrid boron-doped PCD (BDD)/polymer probe for chemical sensing and neural recording. A wafer-level transfer method has been demonstrated to construct whole BDD structures on mechanically flexible Parylene-C substrates [2].

NOTES:

3:45-4:15 p.m. Professor Makarov Denys, The Leibniz Institute for Solidstate and Materials Research, Dresden, Germany (Invited)

Title: Active and Passive Electronics for Smart Implants (Paper ID I10B02)

Abstract: Electronics of tomorrow will be flexible and will form a seamless link between soft, living beings and the digital world. The unique possibility to adjust the shape of the devices offered by this alternative formulation of the electronics provides vast advantages over the conventional rigid devices particularly in medicine and consumer electronics. There is already a remarkable number of available flexible devices starting from interconnects, sensing elements towards complex platforms consisting of communication and diagnostic components [1-4]. We developed flexible [5,6], printable [7,8], stretchable [9,10] and even imperceptible [11] large area passive electronic components with the specific focus on magnetosensitive elements, which were completely missing in the family of flexible electronics, e.g. for smart skin applications. On the other hand, we realized self-assembled compact tubular microchannels based on strain engineering [12] with integrated passive sensory elements [13-15] and communication antenna devices [16] for on-chip and bio-medical applications, e.g. smart implants. Combining these two research directions carried out at different length scales into a single truly interdisciplinary topic opens up the novel field of smart biomimetics. In this respect, we demonstrated mechanically and electrically active compact biomimetic microelectronics, which can serve as a base for realization of novel regenerative neuronal cuff implants with unmatched functionalities. The biomimetic microelectronics can mechanically adapt to and impact the environment possessing the possibility to assess, adopt and communicate the environmental changes and even stimulate the environment electrically. In my talk, these recent developments will be covered.

NOTES:

4:15-4:35 p.m. Professor Yonghong Tan, Shanghai Normal University, China (Contributed)

Title: A Fabrication Approach of Ionic Polymer-metal Composite for Deformation Sensors (Paper ID C8B02)

Abstract: It is known that ionic polymer-metal composite (IPMC) has the characteristics of small size, light weight, flexibility, low-driven voltage and biological compatibility. It has been absorbed engineers' attention to use it for actuators and sensors. As a sensor, IPMC can directly generate voltage or current as the output signal. In this presentation, a method of IPMC fabrication for displacement sensor based on the so-called Nernst equation is proposed. In this method, the electrical potential difference between two electrodes is determined by the ion concentration difference in the clearance inside and near the electrodes.

NOTES:

Time	Session	Title	Location
3:15-4:45 p.m.	Session 10A	Thin-films for Energy Harvesting and Energy Storage	Room 203

Chairs: Yu Wang, Hong Kong Polytechnic University, and Liang Li, Soochow University, China

3:15-3:45 p.m. Professor Xudong Wang, University of Wisconsin, USA (Invited)

Title: High-Performance Photoelectrodes from 3D Nanowire Architectures by High-Temperature Derivatives of Atomic Layer Deposition (Paper ID I10A02)

Abstract: High density tree-like three-dimensional (3D) nanowire (NW) architectures are ideal for high-performance photoelectrodes that could offer long optical paths for efficient light absorption, high quality one-dimensional (1D) conducting channels for rapid electron-hole separation and charge transport, as well as high surface areas for fast interfacial charge transfer and electrochemical reactions. Such structures are typically limited by depth of the NW channels and the density of branch coverage. We developed a surface-reaction-limited pulsed chemical vapor deposition (SPCVD) technique as a derivative of atomic layer deposition (ALD), which grew titanium dioxide (TiO_2) nanorods (NRs) inside dense Si NW arrays. The SPCVD technique effectively decouples the crystal growth from precursor vapor concentration, thus makes the conform growth of dense NW arrays inside highly-confined submicron-sized spaces possible. Dramatic increases of photocurrent and efficiency were obtained when the 3D TiO_2 NR-Si NW architectures were applied as photoelectrochemical (PEC) anodes. Through comprehensive atomistic electron microscopy study of the TiO_2 nanostructures at designed growth cycles, we revealed that the evolution of TiO_2 nanostructures in high-temperature ALD processes follows a path from amorphous layers to amorphous particles to metastable crystallites and ultimately to stable crystalline forms. Such a phase evolution is a manifestation of the Ostwald-Lussac Law, which governs the advent sequence and amount ratio of different phases in high-temperature TiO_2 ALD nanostructures. The amorphous-crystalline mixture enables a unique anisotropic crystal growth behavior at high temperature forming TiO_2 NRs via the principle of vapor-phase oriented attachment. When ZnO nanostructures were used as the supporting templates in the high-temperature TiO_2 ALD growth, TiO_2 tubular nanostructures with well-preserved dimensions and morphology were obtained. This process involved the cation exchange reaction between $TiCl_4$ vapor and ZnO solid and the diffusion of reactants and products in their vapor or solid phases, which was a manifestation of the Kirkendall effect. The evolution of TiO_2 nanotubes from ZnO NW scaffolds was seamlessly integrated with TiO_2 NR branch growth, and thus realized a pure TiO_2-phased 3D NW architecture. Our discovery of high-temperature derivatives of ALD techniques opens a new route toward the design and creation of complex 3D hierarchical nanostructures, which can advantageously impact the devices performance of solar energy harvesting.

NOTES:

3:45-4:15 p.m. Professor Krystof Kempa, Boston College, USA (Invited)

Title: Plasmonic Refraction in Transparent Conductors (Paper ID I10B01)

Abstract: Plasmonic refraction can strongly enhance transparency of transparent conductors. It is based on plasmons mediating energy transfer of the transmitted wave. We identify two basic refraction mechanisms: passive, which involves localized plasmons, and active, the much more efficient refraction with propagating plasmons mediating the transfer. We demonstrate, that in all high performance random metallic perforated networks the passive plasmonic refraction enhances the transmission. We confirm this finding in our random network, based on ultra-long silver nanowires stabilized on a substrate with an UV binder. We show that this network can be used as a high performance transparent electrode for various optoelectronic applications. Based on the effective medium model, we discuss means to boost the transmission by designing networks to operate in the transmission window, with propagating plasmonic modes directly mediating the energy transfer across the network. As an example of this active plasmonic refraction, we demonstrate a very strong transmission enhancement (up to 30%) in a periodic array of gold nanoribbons.

NOTES:

4:15-4:45 p.m. Professor Xihong Hao, Inner Mongolia University of Science and Technology, Inner Mongolia, China (Invited)

Title: High Energy-storage Performance in Lead-based Thick Films (Paper ID I3D01)

Abstract: With the development of electronic devices toward miniaturization, light weight and integration, capacitors with high recoverable energy-storage density and good temperature stability are eagerly desired. Lead-based antiferroelectrics (AFE) and relaxor ferroelectric (RFE) thick films are the promising candidates for application in high energy-storage capacitors, because of their larger difference between maximum polarization and remnant polarization. In this work, lead-based AFE and RFE thick films with a thickness of 1-10 μm were prepared on buffered silicon substrates via chemical solution procedure. A huge recoverable energy-storage density of above 30J/cm^3 was obtained in these thick films due to their higher critical electric breakdown fields. Moreover, in the temperature range from RT to 120°C, these thick films also displayed good temperature-dependent energy-storage stability and moderate energy-storage efficiency.

NOTES:

4:45-5 p.m. COFFEE BREAK

GALA DINNER

7-9 p.m. Jinling Guanyuan International Hotel, Suzhou

Day 3 (Morning) July 6, 2015

Time	Event	Location
8-11 a.m.	Registration	Lobby

Morning Sessions

Time	Session	Title	Location
9-10:30 a.m.	Session 7	Optical Thin Films	Room 201

Chairs: Professors Qiwen Zhan and Imad Agha, CETRASE, University of Dayton, USA

9-9:30 a.m. Professor Tao (Tom) Wu, King Abdullah University of Science and Technology, Saudi Arabia (Invited)

Title: Exploring Photovoltaic and Photoassisted Switching Effects in Oxide Heterostructures (Paper ID I7A01)

Abstract: Recently, interesting photovoltaic effects were observed in oxide thin films and heterostructures, and several approaches related to structural variants and bandgap engineering have been proposed. In fact, some oxides with strongly correlated electrons possess suitable band gaps for photovoltaic applications. Here I will discuss the methods of applying oxides with different band gaps as solar absorbers in photovoltaic devices. Particularly, I will go into details on the advantages and challenges of using Mott insulators in the path-finding process. In a related topic, we used light illumination as an additional parameter to tailor the resistive switching of ferroelectric tunneling junctions and to use photovoltaic effect to sense the memory states.

Notes:

9:30-10 a.m. Professor Guozhong Cao, University of Washington, Seattle, USA (Invited)

Title: Engineering Nanostructures and Interfaces in Excitonic Solar Cells (Paper ID I10A01)

Abstract: Excitonic solar cells including dye-sensitized solar cells, quantum dot-sensitized solar cells, bulk heterojunction organic photovoltaics, are built upon nanostructures of various functional materials. Nanostructures are essential for the high power conversion efficiency, for example, in dye-sensitized solar cells and quantum dot-sensitized solar cells, mesoporous photoanodes made of nanoparticles offer large specific surface area for loading a large amount of dyes or quantum dots so as to capture a sufficient fraction of photons. However, the large surface area of such nanostructures also provide easy pathways for charge recombination, and surface defects and connections between adjacent nanoparticles may retard effective charge injection and charge transport, leading to a loss of power conversion efficiency. Surface facets and chemistry may also affect the conformal coating and adhesion of dye molecules and polymer layers. In this presentation, I will present and discuss our recent work on the design and control of (1) nanostructures and surface chemistry of photoanodes for quantum dot-sensitized solar cells, (2) nonstoichiometric composition, doping, and alignment of quantum dots in quantum dot-sensitized solar cells, (3) the incorporation of plasmonic nanocrystals, and (4) morphologies and chemistry of cathodic buffer layers for inverted polymer solar cells. Our research has demonstrated that the power conversion efficiency can be significantly enhanced with excellent device stability when both nanostructures and interface chemistry are properly engineered.

NOTES:

10-10:30 a.m. Professor Yan-qing Lu, Nanjing University, China (Invited)

Title: (Paper ID I7A02)

Abstract: Not available at the time of printing.

NOTES:

Time	Session	Title	Location
9-10:30 a.m.	Session 9	Sensor Materials and Phase Change Materials	Room 203

Chair: Guru Subramanyam, CETRASE, University of Dayton, USA

9-9:30 a.m. Professor Douguo Zhang, University of Science and Technology of China. (Invited)

Title Thin Films for Fluorescence Emission Controlling (Paper ID I7B01)

Abstract: Fluorescence detection is widely used in the biosciences, medical diagnostics, sequencing and imaging. However fluorescence detection is reaching some natural limits and only incremental improvements in sensitivity — using classical far-field free-space optics — can be expected. To circumvent these limits, we have used the near-field effects of dielectric or metallic multilayer films to control the emission from the dye molecules. The near field optical modes of the films can interact with the nearby fluorophores, which converts the usual omni-directional emission into directional emission and modify the polarization of the coupled emission without the use of any lenses or polarizers. The near-field coupling also results in the separation of wavelengths at different angles and also fluorescence enhancement. In this talk, we will present several experimental works in this field, such as controlling the fluorescence emission with the metallic thin films[1], dielectric multilayer films [2-3], metal-dielectric hybrid films[4-6], and their applications in fluorescence imaging and sensing [7]. All these experiments are carried out with a home-built instrument, leakage radiation microscopy (LRM) [10], which demonstrates great power in characterizing the fluorescence emission and also has the potential to realize the super-resolution fluorescence imaging [8].

Notes:

9:30-10 a.m. Dr. Weisong Wang, CETRASE, University of Dayton, USA. (Invited)

Title: Vanadium Dioxide Thin Film Devices (Paper ID I9A03)

Abstract: Phase change materials have drawn researchers' attention in last decade for new engineering applications due to the advancement of material preparation. The pristine single phase material often demonstrates much more excellent phase change property than the multi-phase family members. As a phase change material, metal insulator transition (MIT) material attracts particular interests in microelectronics recently [1-2]. Among a few MIT materials, VO_2 has demonstrated unique properties for RF applications. In this talk, we will present latest research of this aspect. A couple of vanadium dioxide based RF devices have been designed, fabricated and tested to demonstrate the capability of using this material further in RF. Pulse laser deposition has been studied to obtain the pristine material. With the proper oxygen partial pressure the deposited vanadium dioxide film can achieve four magnitude of resistivity difference between phases.

Notes:

10-10:30 a.m. Professor Xiangang Luo, Institute of Optics and Electronics, Chinese Academy of Sciences, Chengdu, China. (Invited)

Title: Dynamic and Broadband Manipulation of Electromagnetic Waves with Plasmonic Meta-Surface (Paper ID I11B01)

Abstract: Recently, ultra-thin plasmonic metasurface has attracted great attention due to its uniqueness in the manipulation of electromagnetic phase and polarization states. A number of fascinating phenomena and applications based on plasmonic metasurface, including perfect absorbers, radiators, and polarization converters have been demonstrated through the ingenious design in the last decade. Here we give a short review of our recent work on the manipulation of electromagnetic wave with meta-surface. Broadband absorber and polarization transformer with ~2 and ~4 octave bandwidth are realized by dispersion engineering of the meta-surface [1, 2]. Furthermore, we demonstrate that the traditional Planck's limit can be rewritten by combining the material dispersion and coherent method [3]. Another advantage for this method is that the performance of the devices can be dynamically modulated. We believe our strategy would provide a general route for the development of high-efficient, broadband and dynamic metasurfaces.

References:

1 Qin Feng, Mingbo Pu, Chenggang Hu, and Xiangang Luo, Opt. Lett. 37, 2133 -2135 (2012).

2 Yinghui Guo, Yanqin Wang, Mingbo Pu, Zeyu Zhao, Xiaoyu Wu, Xiaoliang Ma, Changtao Wang, Lianshan Yan, and Xiangang Luo, Sci. Rep. 5, 8434 (2015).

3 M. Pu, Q. Feng, M. Wang, C. Hu, C. Huang, X. Ma, Z. Zhao, C. Wang, and X. Luo, Opt. Express 20, 2246-54(2012).

Notes:

10:30-10:45 a.m. COFFEE BREAK

Day 3, Morning Sessions

Time	Session	Title	Location
10:45 a.m.-12:15 p.m.	Session 10B	Thin-films for Energy Harvesting and Energy Storage	Room 201

Chairs: Professors Guozhong Cao, University of Washington, USA, and Xudong Wang, University of Wisconsin, USA

10:45-11:15 a.m. Professor Liang Li, Soochow University, China (Invited)

Title: Applications of Atomic Layer Deposition in Solar Cells (Paper ID I10C02)

Abstract: Atomic Layer Deposition (ALD) is a nanoscale deposition technique owing to its ability to fabricate films at a controllable sub-nanometer (usually sub-angstrom) rate and to coat structures that are highly porous and/or tortuous. A variety of applications, including dynamic random access memory, lithium-ion batteries and field-effect transistors, etc., have emerged using deposited materials by ALD. Particularly, interfacial engineering by ALD has led to exciting understanding of interface and surface for solar cells. The rising number of scientific publications on ALD per year testifies to the increasing world-wide interest towards ALD technology. In this presentation, we will demonstrate our recent research progresses on the applications of ALD in various fields of nanomaterials synthesis and solar cells. First, our results reveal that ALD can produce uniform seed layers to induce growth of nanostructures and even it can be directly utilized to prepare some unique nanostructures. Second, we tried to use ALD to manipulate the surface and interface conditions of semiconductor nanostructures, resulting in the improved conversion efficiencies of DSSCs and perovskite solar cells. Finally, ALD was also shown to be an effective technique for solar water splitting. Taken together, it is anticipated that the ALD should greatly contribute to the advances and developments in the fields of solar cells.

NOTES:

11:15-11:45 a.m. Professor Ren-Kui Zheng, Shanghai Institute of Ceramics, Chinese Academy of Sciences, China (Invited)

Title: Ferroelectric Field Effect in Oxide Film/PMN-PT Single Crystal Heterostructures (Paper ID I10B03)

Abstract: Here, I report that heterostructures composed of semiconductive oxide thin films grown on PMN-PT single-crystal substrate exhibit large interfacial charge-mediated electric-fieldcontrol of the electronic transport properties. Using the ZnO:Mn/PMN-PT and SnO2:Co/PMN-PT as model systems, we demonstrate that the electric-field-induced polarization switching of the PMN-PT results in an increase or a decrease of the charge carrier density of the films, leading to a large change of the electronic transport properties of the films. At room temperature, the electric-field-induced relative change in the resistance (DR/R) is 330% at room temperature and reaches to 24060% at 80 K for the SnO2:Co films. Moreover, the resistance of the films can be modulated reversibly by applying a pulse electric voltage across the PMN-PT. X-ray diffraction, PFM, and Hall effect measurements present robust evidence that the electric-field-induced interfacial electric charges but not the lattice strain play the dominant role in determining the sign and magnitude of the resistance change in these ferroelectric field effect transistors. Our results show that interfacial charge-mediated electric-field-control of the properties of oxide films grown.

NOTES:

11:45 a.m.-12:15 p.m. Professor Yu Wang, Hong Kong Polytechnic University, Hong Kong, China (Invited)

Title: (Paper ID I10C01)

Abstract: Not available at the time of printing.

NOTES:

Time	Session	Title	Location
10:45 a.m.-12:15 p.m.	**Session 11**	**Novel Processing, Characterization and Applications of Thin films**	**Room 203**

Chair: Bo Hou, Soochow University, China

10:45-11:15 a.m. Professor Jinwei Gao, South China Normal University, China (Invited)

Title: Solution-Processed Metallic Network as a High Performance Transparent Conductive Electrodes (Paper ID I11A01)

Abstract: Materials with a simultaneous high electrical conductivity and optical transmittance are essential for various optoelectronic devices. In this work, we have developed an inexpensive, highly transparent, conductive and mechanically flexible metallic network electrode via a self-formed template/mask, which contains a random, but highly uniform network of line-cracks for subsequent selective metal deposition. The resulting structure could be used as an excellent electrode for various flexible photonic and photovoltaic applications, exceeding the electro-optical performance of the state-of-the-art alternatives, such as ITO. We also demonstrate the applications of our Ag network in solar cell, touch screen, smart window, and film heater.

NOTES:

11:15-11:45 a.m. Professor Jinxing Zhang, Beijing Normal University, China (Invited)

Title: Mechanical Switching of Nanoscale Multiferroic Phase Boundaries (Paper ID I11A02)

Abstract: Tuning the lattice degree of freedom in nanoscale functional crystals is critical to exploit the emerging functionalities such as piezoelectricity, shape-memory effect, or piezomagnetism, which are attributed to the intrinsic lattice-polar or lattice-spin coupling. Here I will present that a mechanical probe can be a dynamic tool to switch the ferroic orders at the nanoscale multiferroic phase boundaries in $BiFeO_3$ with a phase mixture, where the material can be reversibly transformed between the "soft" tetragonal-like and the "hard" rhombohedral-like structures. The microscopic origin of the nonvolatile mechanical switching of the multiferroic phase boundaries, coupled with a reversible 180° rotation of the in-plane ferroelectric polarization, is the nanoscale pressure-induced elastic deformation and reconstruction of the spontaneous strain gradient across the multiferroic phase boundaries. The reversible control of the room-temperature multiple ferroic orders using a pure mechanical stimulus may bring us a new pathway to achieve the potential energy conversion and sensing applications.

Reference:

Y.J.Li, et al. Adv. Funct. Mater. DOI: 10.1002/adfm.201500600 (2015).

NOTES:

11:45 a.m.-12:15 p.m. Professor Bo Hou, Soochow University, China (Invited)

Title: Broadband Electromagnetic Absorption of Transparent Conductor Films (Paper ID I11B02)

Abstract: Absorption of microwave by metallic conductors is typically inefficient, albeit naturally broadband, due to the huge impedance mismatch between metal and free space. Reducing metal to ultrathin profile may improve the absorption efficiency, but is still bounded by a maximal 50% limit induced by the field continuity [1]. Here, we experimentally show that broadband, perfect (100%) absorption of microwave can be realized in a single layer of ultrathin conductive film (transparent conductor) when it is illuminated coherently by two oppositely incident beams [2]. Inheriting the intrinsic broadband feature of metal, the complete absorption is frequency-independent in the spectrum which spans 6-18GHz in our microwave experiments and may range from kilohertz to gigahertz frequencies in theory. Remarkably, it occurs in films with thicknesses that are at the extreme subwavelength scales, ~λ/10000 or less. Furthermore, the coherent illumination requires a zero-path-delay interferometer for the two counter-propagating coherent beams at every frequency, which can be equivalently regarded as a frequency-independent magnetic boundary [3].

References:

1 Li, S. C. et al. "Microwave absorptions of ultrathin conductive films and designs of frequency-independent ultrathin absorbers," *AIP Advances* 4, 017130 (2014).

2 Li, S. C. et al. "Broadband perfect absorption of ultrathin conductive films with coherent illumination: super performance of electromagnetic absorption," (http://arxiv.org/abs/1406.1847).

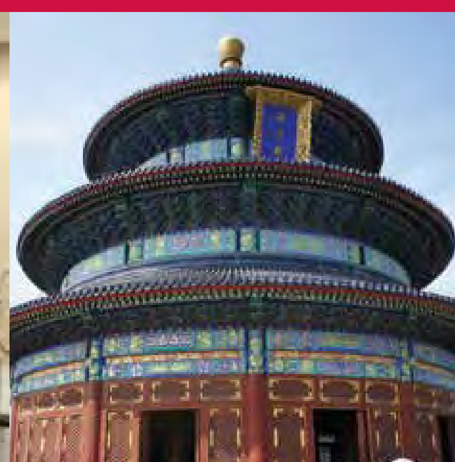
3 Li, S. C. et al. "An equivalent realization of coherent perfect absorption under single beam illumination," *Scientific Reports* 4, 7369(2014).

NOTES:

CLOSING CEREMONY

12:15-12:30 p.m. Room 203

12:30-1:30 p.m. LUNCH



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THANK YOU FOR YOUR PARTICIPATION IN THE INAUGURAL INTERNATIONAL WORKSHOP ON THIN-FILMS FOR ELECTRONICS, ELECTRO-OPTICS, ENERGY AND SENSORS (TFE3S).