4th International Conference on

Condensed Matter and Materials Physics

August 16-17, 2018 | London, UK

Keynote Forum

Day 1

Materials Physics 2018

Subhendra Dev Mahanti, Res. Rev. J Mat. Sci. 2018, Volume 6
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Subhendra Dev Mahanti

Michigan State University, USA

Recent advances and challenges in thermoelectrics

Global energy issues have created a pressure to increase both the use of renewable sources of energy and the efficiency of current power generation and utilization. In the latter context thermoelectricity can play an important role in addressing the problems of energy utilization and management. The major challenge facing the thermoelectric research is to improve the efficiency which depends on dimensionless figure of merit $ZT = S^2\sigma T/\kappa$ (S is thermopower, σ is electrical conductivity, x is total thermal conductivity usually dominated by the phonons and T is the operating temperature). To achieve higher efficiency, ideas like quantum confinement, electron crystal phonon glass, nanostructuring, hierarchical structures, energy filtering, low-dimensional charge transport created by highly anisotropic electronic band structure, etc. have impacted the field of thermoelectrics during the last several decades. In this talk I will review some of the recent advances in the field and discuss how *ab initio* theoretical calculations are contributing to and clarifying these ideas. Some of the systems I will discuss are (i) thermoelectric materials with intrinsically low thermal conductivity such as layered SnSe and bulk systems with effective superlattice structure Bi(CuSe)O and Sr(AgSe)F where CuSe(AgSe) layers are sandwiched between Bi-O (Sr-F) layers; (ii) 3-dimensional systems with highly anisotropic electronic bands as in Heusler systems. I will also briefly discuss recent work on computationally guided discovery of novel thermoelelctric materials for example, n-type Zintl compounds.

Recent Publications

1. D Bilc et al. (2004) Resonant States in the Electronic Structure of High Performance Thermoelectrics $AgPb_mSbTe_{2+m}$; the role of Ag-Sb microstructures. Phys. Rev. Letters. 93(14):146403.
2. S Ahmad et al. (2006) *Ab initio* study of deep defect states in narrow band-gap semiconductors: group iii impurities in PbTe. Phys. Rev. Letters: 96(5):056403.
3. K Hoang et al. (2007) Atomic ordering and gap formation in Ag-Sb based ternary chalcogenides. Phys. Rev. Letters. 99(15):156402.
4. Dat T Do and S D Mahanti (2014) Bonds, bands, and bandgaps in tetrahedrally bonded ternary compounds: the role of group V lone pairs. Journal of Physics and Chemistry of Solids. 75(4):477-485.
5. Y O Ciftci and S D Mahanti (2016) Electronic structure and thermoelelctric properties of half-Heusler compounds with eight valence electron count – KScX (X=C and Ge). Journal of Applied Physics. 119(14):145703.

Biography

Subhendra Dev Mahanti obtained his BSc from Utkal University in 1961; MSc from Allahabad University in 1963; PhD in Theoretical Condensed Matter Physics from the University of California, Riverside (USA) in 1968. After two years at Bell Telephone Laboratories, he joined Michigan State University in 1970, where he has been a Full Professor since 1982 and is currently an Emeritus Professor. His research is in the area of magnetism, high T_c superconductors, multi-ferroics, physical systems showing colossal magnetic resistance, thermoelectrics, and topological insulators. He has published nearly 300 papers in reputed journals.

mahanti@pa.msu.edu

Sang Yeol Lee, Res. Rev. J Mat. Sci. 2018, Volume 6
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Sang Yeol Lee

Cheongju University, Republic of South Korea

Thin film circuits with amorphous oxide thin film transistor

Amorphous oxide thin film transistors (AOTFT) have been fabricated by RF (Radio Frequency) magnetron sputtering with the bottom gate structure. AOTFTs exhibited to change stability under the bias and temperature stress and electrical properties strongly depending on Si ratio, mainly because Si atom can act as a good carrier suppressor. Therefore, the threshold voltage (V_{th}) of AOTFTs could be easily controlled by changing the Si ratio. Depletion load inverter model has been consisted by using only n-type AOTFTs. This inverter model is operated by difference of V_{th} between depletion mode (D-mode) and enhancement mode (E-mode) controlled by Si ratio. Furthermore, the conventional NMOS logic circuit models was adopted for the realization of AOTFT-based logic circuits such as NAND, NOR and ELSE. The proposed logic circuit composed by only n-type AOTFTs could be promising in terms of high performance and simply controllable thin film type for next generation integrated circuit applications.

Biography

Sang Yeol Lee obtained his BS Degree in the Department of Electrical Engineering at Yonsei University (Republic of South Korea) in 1986; MS and PhD Degrees in the Department of Electrical and Computer Engineering from State University of New York at Buffalo (USA) in 1990 and 1992, respectively. He has been a Full Professor in the Department of Semiconductor Engineering at the Cheongju University; Full Professor and Director of Research Institute of Advanced Semiconductor Convergence Technology. He was invited as a Visiting Scholar in Electronic Device Team, Los Alamos National Lab (USA) in 2002–2003. His research areas are ZnO electronics including oxide TFTs, LEDs, transparent conducting oxides, semiconductor processing, nanoelectronics, memory devices and displays. He is mainly interested in Materials Science.

sylee@cju.ac.kr

Notes:

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Day 2

Chao Nan Xu, Res. Rev. J Mat. Sci. 2018, Volume 6
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Chao Nan Xu

National Institute of Advanced Science and Technology, Japan

Approaches to the new field of multi-piezo: Ceramics, films and composites

Piezoluminescence, which is also called elasticoluminescence, is a form of mechanoluminescence (ML) during the elastic deformation, which has attracted considerable attention because it can be repeatedly used for mechano-optical conversion. Elastic ML offers the advantages of wireless detection and nondestructive analysis, making it a promising candidate for various applications, such as stress sensing and damage diagnosis, and in particular for immediate *in situ* dynamic visualization of stress distribution in industrial plants, buildings, and living organisms. In piezoelectric materials, mechanical stimuli generate electricity, a phenomenon that is widely utilized in industry and daily life. Recently, we have found the first well-known piezo multifunctional material that exhibits both piezoelectricity and efficient elastic ML. By precisely tuning the Li/Nb ratio in nonstoichiometric $LiNbO_3:Pr^{3+}$, a material that exhibits an unusually high piezoluminescence intensity, which far exceeds that of any well-known piezoelectric material, is produced. $LiNbO_3:Pr^{3+}$ shows excellent strain sensitivity at the lowest strain level, with no threshold for stress sensing. These multipiezo properties are useful for nano-micro sensing, damage diagnosis, electro-mechano-optical energy conversion, and multifunctional control in optoelectronics.

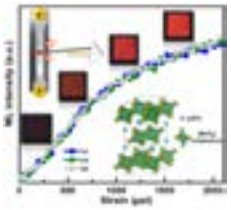

Figure 1: ML response of LiNbO3:Pr.

Recent Publications

1. J Li et al. (2018) Tailoring bandgap and trap distribution via Si or Ge substitution for Sn to improve mechanoluminescence in $Sr_3Sn_2O_7:Sm^{3+}$ layered perovskite oxide. Act. Mater. 145:462-469.
2. D Tu et al. (2017) $LiNbO_3:Pr^{3+}$: a multi-piezo material with simultaneous piezoelectricity and sensitive piezoluminescence. Adv. Mater. 29(22):1-4.
3. A Yoshida et al. (2017) Mechanoluminescent testing as an efficient inspection technique for the management of infrastructures. J. Disas. Res. 12(3):506-514.
4. Y Fujio et al. (2016) Sheet sensor using $SrAl_2O_4$:Eu mechanoluminescent material for visualizing inner crack of high-pressure hydrogen vessel. Int. J. Hydrogen Energy. 41(2):1333-1340.

Biography

Chao Nan Xu is the Principle Research Manager at National Institute of Advanced Science and Technology (AIST), Founder and Chair of Mechanoluminescence Technology Consortium, Fellow of the Ceramic Society of Japan. She has been concurrently serving as Full Professor of New Material Lab at Kyushu University since 2005. She discovered the intensive new type of elasticoluminescence, and established the hybrid concept of inorganic/organic composite coating (skins) and the principle for quantitative analysis of stress/strain and faults. She also made discovery of grain size effect for gas sensitivity. She pioneered the new repeatable mechanoluminescent materials and their novel applications particularly in lighting, health care, and stress/strain visualization.

cn-xu@aist.go.jp

Samit K Ray, Res. Rev. J Mat. Sci. 2018, Volume 6
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Samit K Ray
S N Bose National Centre for Basic Sciences, India

2D/SI heterostructures for photonic devices

We shall review our recent work on 2D/3D heterostructures for several electronic and photonic devices. The device using GO/Si on illumination shows a broadband (300 nm-1100 nm) spectral response with a characteristic peak at ~700 nm, in agreement with the photoluminescence emission from GO. Very high photo-to-dark current ratio (>10^5) is observed upon illumination of UV light. On the other hand, transition metal dichalcogenides (TMDC), an emerging class of two dimensional materials are interesting due to the presence of a finite and direct energy gap in low dimensions, with a wide range of electronic and optical attributes. We have demonstrated the ability to gradually tailoring the optical properties of MoS_2 nanocrystals in terms of PL response and optical absorption, making them attractive for future photonic devices. Chemical doping and plasmonic enhanced photoresponsivity of two dimensional (2D) n-WS_2/p-Si heterojunctions have also been demonstrated. A sharp band-edge absorption of the hybrid material indicates the presence of spin–orbit coupled direct band gap transitions in WS_2 layers, in addition to a broader plasmonic peak attributed to Ag nanoparticles. Stabilized Ag-nanoparticle (~4–6 nm) embedded electron rich n-WS_2 has been used to fabricate plasmon enhanced, silicon compatible heterojunction photodetectors. The detectors exhibited superior properties, possessing a photo-to-dark current ratio of ~10^3, a very high responsivity (8.0 A W^{-1}) and an EQE of 2000% under 10 V bias. The results provide a new paradigm for intercalant impurity-free metal nanoparticle assisted exfoliation of n-type few-layer WS_2,, with the nanoparticles playing a dual role by inducing chemical doping as well as tunable plasmon enhanced absorption.

Recent Publications

1. R K Chowdhury et al. (2017) Synergistic effect of polymer encapsulated silver nanoparticle doped WS_2 sheets for plasmon enhanced 2D/3D heterojunction photodetectors. Nanoscale. 9:15591-15597.
2. A Ghorai et al. (2017) Highly luminescent WS_2 quantum dots/Zno heterojunctions for light emitting devices. ACS Appl. Mater. Interfaces. 9:558-565.
3. S Mukherjee et al. (2017) Solution processed, hybrid 2D/3D MoS_2/Si heterostructures with superior junction characteristics. Nanotechnology. 28(135203):1-11.
4. R K Chowdhury et al. (2016) Novel silicon compatible p-WS_2 2D/3D heterojunction devices exhibiting broadband photoresponse and superior detectivity. Nanoscale. 8(27):13429-13436.
5. S Mukherjee et al. (2016) Novel Colloidal MoS_2 Quantum Dot Heterojunctions on Silicon Platforms for Multifunctional Optoelectronic Devices. Scientific Reports. 6:29016.

Biography

Samit K Ray is currently the Director of S N Bose National Centre for Basic Sciences, Kolkata on lien from Indian Institute of Technology, Kharagpur. His research interests are in the area of semiconductor nanostructures, quantum dots, photovoltaics, nanodevices and electronic materials. He has published more than 300 research papers in peer reviewed journals, seven book chapters and co-authored a book on *"Strained Silicon Heterostructures: Materials and Devices"* published by IEE, UK.

samit@bose.res.in