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21st International Conference on

Advanced Energy Materials and Research

July 11-12, 2019 | Zurich, Switzerland

Keynote Forum

Day 1

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Yuichi Setsuhara

Osaka University, Japan

Reactive plasma processes for formation of high-mobility IGZO thin film transistors

Reactive plasma process systems have been developed via installation of inductively-coupled plasmas (ICP) sustained with low-inductance antenna (LIA) for low-temperature fabrication of flexible electronics, which require large area and low damage processes with reactivity control capabilities at low substrate temperature. Major advantage of the reactive processing system is that the reactivity during film-deposition processes can be enhanced and controlled via low-damage and high-density plasma production for low-temperature processing of devices. The reactive plasma processes have been applied to sputtering deposition of transparent amorphous oxide semiconductor a-InGaZnOx (a-IGZO), which has attracted great attentions as key material for next-generation flexible electronics. So far post annealing at elevated temperature (as high as 400°C) was required. Thus the conventional process for fabrication of the IGZO TFTs has been carried out on glass substrates. With the advanced reactivity controlled plasma processes in this study, a-IGZO thin-film transistors (TFTs) with mobility as high as or higher than 40 cm^2/Vs was successfully formed at substrate temperature less than 200°C. In this presentation, the reactive plasma processes are presented for low-temperature formation of IGZO TFTs.

Recent Publications

1. K Takenaka, M Endo, G Uchida and Y Setsuhara (2018) Fabrication of high-performance InGaZnOx thin film transistors based on control of oxidation using a low-temperature plasma. Applied Physics Letters 112:152103.
2. K Takenaka, Y Setsuhara, J G Han, G Uchida and A Ebe (2018) Plasma-enhanced reactive linear sputtering source for formation of silicon-based thin films. Review of Scientific Instruments 89(8):083902.
3. Kosuke Takenaka, Yoshikatsu Satake, Giichiro Uchida and Yuichi Setsuhara (2017) Low-temperature formation of C-axis orientated aluminum nitride thin films with plasma-assisted reactive pulsed-DC magnetron sputtering. Japanese Journal of Applied Physics 57: 01AD06.

4. Kosuke Takenaka, Keitaro Nakata, Giichiro Uchida, Yuichi Setsuhara and Akinori Ebe (2016) Effects of working pressure on the physical properties of a-InGaZnOx films formed using inductively-coupled plasma-enhanced reactive sputtering deposition. IEEE Transactions on Plasma Science 44:3099.
5. K Takenaka, K Nakata, H Otani, S Osaki, G Uchida and Y Setsuhara (2016) Process controllability of inductively coupled plasma-enhanced reactive sputter deposition for the fabrication of amorphous in GaZnOx channel thin-film transistors. Japanese Journal of Applied Physics 55:01AA18

Biography

Yuichi Setsuhara received his Dr Eng. in Electrical Engineering from Osaka University in 1991. He joined Welding Research Institute, Osaka University as Research Associate in 1991, Department of Aeronautics and Astronautics, Graduate School of Engineering, Kyoto University as Associate Professor in 2001, and has been a Professor in Joining and Welding Research Institute, Osaka University since 2004. He is currently a Vice Director of Joining and Welding Research Institute (JWRI), Osaka University since 2014. He has published more than 150 papers in SCI journals and has been serving as Board Members of several committees such as International Scientific Committee for International Conference on Plasma Surface Engineering and International Advisory Board for the journal "Plasma Processes and Polymers".

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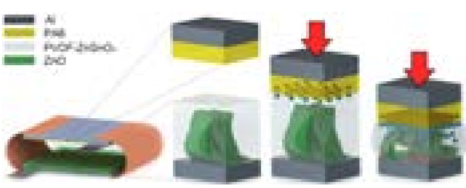
Jikui Luo

University of Bolton, UK

Material synthesis and optimization for high performance triboelectric nano generators

Energy harvesting technology is an emerging technology, particularly important for the wireless sensor networks as it is the core technology for internet of things (IoT), smart manufacturing and smart cities, etc. Since, wireless sensors are typically installed on mobile objects, in remote areas or harsh environments, it is extremely challenging to maintain their long-term sensing/monitoring function due to the requests for constant electrical power or periodical replacement of batteries. Energy harvesting technologies have been explored to power wireless sensors by utilizing piezoelectric, pyroelectric, electromagnetic and triboelectric effects. Triboelectric nanogenerator (TENG) is regarded as the most suitable one owing to its very high power outputs and conversion efficiency. Great efforts focus on the performance enhancement through the innovations to increase surface charge density. Searching for better materials and optimal combination and modifying materials properties are the two common methods for obtaining triboelectric materials with high surface charge densities. We have been working on these for a while and achieved composite materials with excellent triboelectric properties and various optimal material combinations for TENGs. The talk will highlight our work on the best tribo-positive materials, synthesis of tribo-negative composites using polyvinylidene difluoride (PVDF) or polytetrafluoroethylene (PTFE) incorporated with piezo/ferroelectric nanomaterials such as ZnO and Barium titanate (BTO) etc, and specific design for the electrode and tribomaterial interfaces. Using the best material combination and optimized device structures, we have fabricated flat-surface TENGs with peak voltage output over 1200 V and instantaneous power density in the range of 40-120 W/m^2 with excellent stable function. Author will also present our latest unique technologies of the TENG-based chipless wireless sensors with self-identification capability and TENG as a wireless power source.



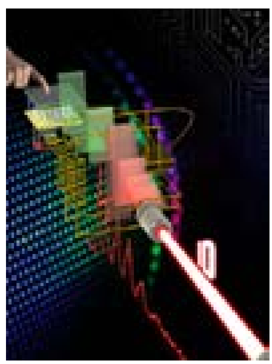


Figure 1: Schematic and working mechanism of the TENG with an incorporated interfacial ZnO nanosheets piezoelectric layer.

Figure 2: Schematic drawing of the instantaneously self-powered chipless wireless sensors with self-identification capability.

Recent Publications

1. H Zhang, L W Quan, J K Chen, C K Xu, C H Zhang, S R Dong, C F Lu and J K Luo (2019) A general optimization approach for contact-separation triboelectric nanogenerator, Nano energy 56:700.
2. L Shi, S R Dong, P Ding, J K Chen, S T Liu, S Y Huang, H S Xu, U Farooq, S M Zhang, S J Li and J K Luo (2019) Carbon electrode enables flat surface PDMS and pa6 triboelectric nanogenerators to achieve significantly enhanced triboelectric performance. Nano energy 55:548.
3. P F Zhao, N Soin, K Prashanthi, J K Chen, S R Dong, E P Zhou, Z G Zhu, A A Narasimulu, C D Montemagno, L Y Yu and J K Luo (2018) Emulsion electrospinning of polytetrafluoroethylene (PTFE) nanofibrous membranes for high-performance triboelectric nanogenerators, ACS Appl. Mater. & Interface. 10:5880.
4. P Ding, J K Chen, U Farooq, P F Zhao, N Soin, L Y Yu, H Jin, X Z Wang, S R Dong and J K Luo (2018) Realizing the potential of polyethylene oxide as new positive tribo-material: over 40 W/m^2 high power flat surface triboelectric generators. Nano energy 46:63.
5. R Z Pan, W P Xuan, J K Chen, S R Dong, H Jin, X Z Wang, H L Li and J K Luo (2018) Fully biodegradable triboelectric nanogenerators based on electrospun polylactic acid and nanostructured gelatin films. Nano energy 45:193

Biography

Jikui Luo received his PhD Degree from the University of Hokkaido, Japan in 1989. He worked in Cardiff University as a Research Fellow, in Newport Wafer Fab., Philips Semiconductor Co. and Cavendish Kinetics Ltd as an Engineer, Senior Engineer and Manager and then in Cambridge University as a Senior Researcher from 2000. From January 2007, he became a Professor in MEMS at the Centre for Material Research and Innovation (CMRI), University of Bolton. His current research interests focus on sensors, actuators, flexible/wearable electronics and lab-on-chips for biotechnology and healthcare applications and nanomaterials, nanodevices, energy harvesting technology, wireless sensors, etc. He has over 230 publications in peer review international journals, and about 190 talks and presentations at international conferences, among them about 40 are invited talks or plenary/keynote speaks.

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Pascal Boulet
Aix-Marseille University, France

Charge density distribution as a tool for understanding relationships between structure and properties of thermoelectrics

For three decades density-functional theory (DFT) has imposed itself as an accurate quantum method to investigate materials properties from the perspective of the charge density, which is readily accessible from fast calculations. In parallel, developments of density-based descriptors such as Bader's quantum theory of atoms in molecules (QTAIM) brought new insights into materials properties. The thermoelectric properties (TE) can be evaluated from combined DFT electronic band structures calculations and Boltzmann's semi-classical formalism. It is well known that TE properties may be significantly affected by structure modifications such as doping, nano-structuring or strains application. In this lecture author will present results of TE properties calculations performed on modified materials and their relationships with the perturbations induced by these modifications on the electronic band structure and on the crystal atomic structure and bonding network investigated using Bader's theory of atoms in molecules.

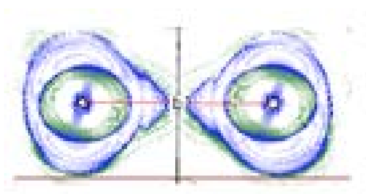

Figure: Electron density laplacian between two atoms in resonant interaction.

Recent Publications

1. Koga T, Sun X, Cronin S B and Dresselhauss M S (1999) Carrier pocket engineering applied to "strained" Si/Ge superlattices to design useful thermoelectric materials. Applied Physics Letters 75:2438-2440.
2. Heremans J P, Wiendlocha B and Chamoire A M (2012) Resonant levels in bulk thermoelectric semiconductors. Energy & Environmental Science 5:5510-5530.
3. Li H Z, Li R P, Liu J H and Huang M J (2015) Convergence of valence bands for high thermoelectric performance for p-type InN. Physica B 479:1-5.
4. Christensen M, Abrahamsen A B, Christensen N B, Juranyi F, Andersen N H, Lefmann K, Andreasson J, Bahl C R H and Iversen B B (2008) Avoided crossing of rattler modes in thermoelectric materials. Nature Materials 7:811-815

Biography

Pascal Boulet has earned his PhD thesis Diploma from both the University of Lyon, France and the University of Geneva, Switzerland in 2001 under the supervision of Prof H Chermette and Prof J Weber. His PhD thesis was related to the density-functional theory calculations on heterogeneous catalytic processes, photochemical processes in organic and organometallic species using time-dependent DFT and electron density based chemical reactivity indexes. He then moved to University College London, UK in Prof P V Coveney's group where he worked as a Postdoctoral Research Fellow on clay polymers nanocomposite materials using monte carlo and molecular dynamics simulations. From 2004 to 2017, he was Associate Professor at the University of Aix-Marseille, France where he got a full professorship position in 2017. His field of interest mainly deals with transport properties in bulk and low-dimensional materials for energy applications (thermoelectricity and photovoltaics). He has published over 60 papers in renowned journals.

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