DAY 1 Keynote Forum

JOINT EVENT

22nd International Conference on

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&

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M Turemis, Nano Res Appl 2018, Volume 4
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1-D ZnO/PANI and ZnO/PPy composites based photoluminescence sensor for detection of acetic acid involved in cultural heritage deterioration

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Cultural heritage is seriously threatened by the presence of low concentrations of destructive gases and VOCs from indoor air at museums. Typically, primarily responsible of artefact degeneration are composed of acetic acid and NO/NO_2. Thus, a device that can detect those gases and O_2 simultaneously would be most beneficial in preservation of the cultural heritage. In this study, we are aimed to develop a sensor array, within the NEMOSINE project GA760801, composed of three sensing module to detect acetic acid, NO and O_2 simultaneously. At the first stage, 1D ZnO nanorods and nanowires were synthesized and conducting polymers of polyaniline (PANI) and polypyrrole (PPy) was formed by solution polymerization method. Interaction between ZnO nanoparticle and conducting polymers has been studied using X-ray diffraction (XRD), SEM and PL spectroscopy. The ammonia gas sensing behaviours of the ZnO/PANI and ZnO/PPy composites were examined at various ambient conditions. Newly designed chamber was used to hold sensing layer, excitation light and detectors. The acetic acid sensor, changes its photoluminescence when the sensing film adsorbs or desorbs acetic acid in gas status. An optical fibre is employed to measure variations in photoluminescence of the ZnO-conducting polymer in the presence of acetic acid vapour. Experimental results show that the sensitivity of the acetic acid is about 0.4 ppm at operating temperatures ranging from 25 to 40°C in air with a linear range 0.5-100 ppm. The response time was very short, which was 3.5 s when the target gases switched from 0 ppm to 1 ppm, and 10 s for regeneration of initial signal for subsequent measurements. Comparatively, we assembled complementary metal oxide semiconductor substrate (CMOS) composed of metal oxide semiconductor (MOS) nanostructures as a resistive type sensor integrated with a readout circuit and heater on a chip for monitoring the presence of VOC samples in the air. The results suggest that this novel ZnO/PANI composite based nanosensor and complementary miniaturized CMOS sensor shows great potential in the field of mobile environmental air monitoring and could also be modified by different sensitive materials to detect various molecules or ions in the future.

Recent Publications

1. Turemis M et al., (2018) Optical biosensor based on microalga-paramecium symbiosis for improved marine monitoring. Sensors and Actuators B: Chemical 270:424-432.
2. Turemis M et al., (2017) A novel optical/electrochemical biosensor for real time measurement of physiological effect of astaxanthin on algal photoprotection. Sensors and Actuators B: Chemical 241:993-1001.
3. Viter R et al., (2014) Application of room temperature photoluminescence from ZnO Nano-rods for Salmonella detection. IEEE Sensors Journal 14:2028-2034.
4. Viter R et al., (2016) Bioanalytical system for detection of cancer cells with photoluminescent ZnO nanorods. Nanotechnology 27:465101.

Biography

M Turemis received his MSc degree in Biochemistry from Ege Universitesi, Izmir, Turkey in 2010 and a PhD degree in Biotechnology from the Università della Tuscia of Viterbo within ITN Marie Curie project. Currently he is working as an experienced researcher at Biosensor S.r.l. His research interests focus on the development and characterization of biosensors and their applications in the field of medicine, water treatment, and biotechnologies.

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Katsuhiro Tomioka, Nano Res Appl 2018, Volume 4
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Integration of III-V nanowires on Si and their transistor applications

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Difficult issue for achieving ultralow power LSI is lowering supply voltage of FETs while overcoming physical limitation of sub threshold slope (SS=2.3 kBT/q=60 mV/dec). This limitation will stop further scaling of the power consumption even if multi gate architecture and III-V/Ge channels are implemented. The steep slope transistors such as tunnel FETs (TFETs) and negative capacitance FETs have therefore been proposed to overcome the limitation. The TFETs are most promising switching devices because of scalability for lower SS than 60 mV/dec and better compatibility with conventional integration process. However, there are some difficulties in decreasing SS while increasing on current as high as that of conventional FETs. Recently, we have successfully integrated vertical III-V nanowires on Si and Ge substrates by selective area growth. The important point for the heterogeneous integration was to modify the initial Si or Ge surfaces to (111) B-polar and we demonstrated high performance III-V NW based vertical FETs using modulation doped core multi shell layers. Beside the application, we proposed a new tunnel junction based on III-V/Si interface which is formed by selective area growth of III-V nanowires (NWs) on Si and demonstrated vertical TFETs with steep SS. This new tunnel junctions can inherently forms abrupt heterojunction regardless of precise doping because the band discontinuity is determined only by the offset of each III-V and Si. Thus, good gate electrostatic and depletion width controlling are defined only by the III-V channel region. In this presentation we report on recent progress in these heterogenous integrations of III-V nanowires on Si and Ge and device applications such as the vertical III-V NW FETs on Si/Ge and steep-slope TFETs using the III-V NW/Si heterojunctions. In TFET application, we present new approach of increasing tunneling current which is inherently low current. The new TFET using III-V NW/Si junction demonstrate rapid current enhancement and exhibit very high trans conductance efficiency which was much higher than the physical limitation of Si MOSFET-based analog integrated circuits.

Recent Publications

1. K. Tomioka, J. Motohisa, S. Hara, T. Fukui, Nano Letters, 2008, 8, 3475.
2. K. Tomioka, F. Ishizaka, T. Fukui, Nano Letters, 2015, 15, 7253.
3. K. Tomioka, M. Yoshimura, T. Fukui, Nature, 2012, 488, 189.

Biography

Katsuhiro Tomioka has completed his BE and MS degree in Electrical Engineering at Gunma University, Japan in 2003 and 2005 respectively and PhD in Electronics and Information Engineering at Hokkaido University, Sapporo, Japan in 2008. Since, 2016 June he is working as an Associate Professor at Hokkaido University. His current research area is on the formation of semiconductor nanowires and devices for future application to low power electrical switches and optical devices.

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Metal nanoparticle electroless deposition and nanostructure production on silicon

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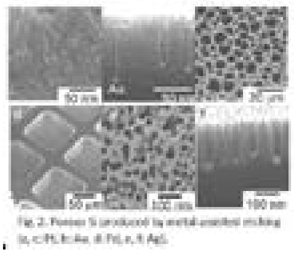
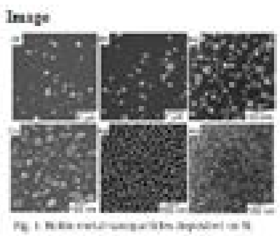
Noble metal nanoparticles on silicon wafers can form microstructures not only by electroless deposition of themselves but also by their catalytic activity for etching of silicon and initiation of electroless metal deposition. We fabricate various noble metal nanoparticles on silicon by electroless displacement deposition and apply them to metal-assisted hydrofluoric acid (HF) etching of silicon autocatalytic electroless deposition of metal on silicon, solar-hydrogen production using photoelectrochemical cells, and noble metal recovery from waste electrical and electronic equipment. In this presentation, noble metal nanoparticles and nanostructures formed on silicon surfaces by these processes are described.





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1. Yae S, Nasu N, Matsumoto K, Hagihara T, Fukumuro N and Matsuda H (2007) Nucleation behavior in electroless displacement deposition of metals on silicon from hydrofluoric acid solutions. Electrochimica Acta 53(1):35-41.
2. Yae S (2011) Solar Cells - New Aspects and Solutions, solar to chemical conversion using metal nanoparticle modified low-cost silicon photoelectrode. Edited by Leonid Kosyachenko, Croatia, 11:231-254, DOI: 10.5772/1759.
3. Yae S, Morii Y, Fukumuro N and Matsuda H (2012) Catalytic activity of noble metals for metal-assisted chemical etching of silicon. Nanoscale Research Letters 7:352.
4. Hagihara T, Yaori K, Iwakura K, Fukumuro N and Yae S (2015) Electrochemical quartz crystal microbalance study of the electrodeposition of platinum. Electrochimica Acta 176:65-69.
5. Fukuda K and Yae S (2016) Electroless displacement deposition of gold from aqueous source —recovery from waste electrical and electronic equipment (WEEE) using waste silicon powder in the book The Recovery of Gold from Secondary Sources, Edited by Syed Sabir, Imperial College Press, London, 3:57-94, DOI: 10.1142/9781783269907_0003.

Biography

S Yae is a Professor in the Department of Chemical Engineering and Materials Science, Graduate School of Engineering, University of Hyogo. He holds a PhD degree from Osaka University, Osaka, Japan. He was a Research Associate at Osaka University from 1990 to 1998, and an Assistant and Associate Professor at Himeji Institute of Technology (presently University of Hyogo) from 1998 to 2015. He is the Vice-Chief Editor of ***Journal of the Surface Finishing Society of Japan*** and the Secretary General of the 3rd International Symposium on Anodizing Science and Technology AST2019, which will be held in Awaji Island, Hyogo, Japan from 2nd to 5th June 2019. He has published more than 90 original papers in reputed journals and five book chapters.

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EuroSciCon

DAY 2

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Controlled self-assembly of Ge Si nanostructures and its perspective in Si micro cavities

Zhenyang Zhong

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Monolithic integration of Si based microelectronics and optoelectronics is expected to be the viable solution to overcome the performance of bottleneck for semiconductor microchips in terms of power consumption, speed and band width. Ge Si quantum nanostructures (QNs) have been of great interest for their potential in both microelectronic and optoelectronic device applications, considering their unique properties and the compatibility with the sophisticated Si technology. However, the poor quantum efficiency of the Ge/Si system associated with the indirect band structure hampers their applications in the optoelectronic devices. It is found that the quantum confinement effect and the partial relaxation of the law of momentum conservation can considerably increase the quantum efficiency of the Ge Si nanostructures. Further improvement can be realized by embedding Ge Si QNs into some micro cavities since the light-matter interaction in the cavity can be dramatically enhanced. It is a critical issue to realize the spatial matching, as well as the spectra matching, between the Ge Si QNs and the cavity. In this talk, controlled Ge Si QNs in Si microcavities (micropillars and microdisks) are systematically studied. The periodic Si micropillars and microdisks are fabricated by nano sphere lithography. Controlled Ge Si coaxial quantum wells (CQWs) on periodic Si (001) micropillars in a large area is realized. By tailoring the growth conditions and the diameters of the pillars (or the microdisks), different configurations of Ge Si QNs, including quantum dots (QDs) 'necklace', quantum rings (QRs), quantum dot molecules (QDMs) and single QD are realized on the top edge of the micropillars, as shown in Fig. 1. By reducing the Si pillar into small dot, four self-assembled Ge Si QDs can be induced at the base edges of the Si dot, resulting in the Ge-Si compound QD molecules. Particularly, the Ge Si QNs can be readily modulated by a two-step growth procedure. Such an engineering of Ge Si QNs is explained in terms of the surface chemical potential and the anisotropic surface diffusion of adatoms around the patterned Si microstructures during growth. Our results disclose the critical effect of the surface curvature on the diffusion and the aggregation of Ge adatoms, which further clarify the unique features and the inherent mechanism of self-assembled QDs on patterned substrates. More interestingly, by designing the diameter and the period of the Si microcavities (pillars or disks), the strong coupling between the spontaneous emission of Ge Si QNs and the cavity modes, as well as the effect of the photonic crystal bandgap, will remarkably improve the optoelectronic properties of the Ge Si QNs. Accordingly, the Ge Si QNs embedded in the Si microcavities will have promising futures in the applications of innovative optoelectronic devices.

Biography

Dr. Zhenyang Zhong is a Professor in the Physics Department at Fudan University, China. He has completed his BS at Peking University in 1995 and PhD degree in the Institute of Physics at Chinese Academy of Science, Beijing, China in 2001. He has worked in Institute for Semiconductor Physics at University Linz, Austria from April 2001 to December 2003 and from May 2005 to December 2005 and worked in Max Planck Institute for Solid State Research, Stuttgart, Germany, as a Postdoctoral Research Fellow from April 2004 to April 2005. Since 2006, he is working in the Physics Department at Fudan University. His research interest focuses on the controlled formation of varieties of nanostructures on Si substrates, and the exploration of the unique properties and the applications of those nanostructures. He has authored or coauthored 71 journal articles and 2 book chapters.

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BNT based ceramics with polar nano regions for high power energy storage

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Dielectric capacitors are very attractive for high power energy storage. However, the low energy density of these capacitors, which is mainly limited by the dielectric material, is still the bottleneck for their applications. In this work, lead free single phase perovskite Srx Bi1-xNa0.97-xLi0.03) 0.5TiO3 (x=0.30 and 0.38) bulk ceramics were prepared using solid state reaction method and were carefully studied for the dielectric capacitor application. Polar nano regions (PNRs) were created in this material using co-substitution at A-site to enable relaxor behaviour with low remnant polarization (Pr) and high maximum polarization (Pmax). Moreover, Pmax was further increased due to the electric field induced reversible phase transitions in nano regions. Comprehensive structural and electrical studies were performed to confirm the PNRs and reversible phase transitions and finally a high energy density (1.70 J/cm3) with an excellent efficiency (87.2%) was achieved using the contribution of field-induced rotations of PNRs and PNR related reversible transitions in this material, making it among the best performing lead free dielectric ceramic bulk material for high energy storage.

Biography

Yan H is a Senior Lecturer in Materials in the School of Engineering and Materials Science at Queen Mary University of London (QMUL). He has completed his PhD in Materials Science and Technology at Shanghai Institute of Ceramics in 2001. Since that he joined QMUL as an Academic Visitor and Research Assistant. At QMUL, he was appointed as an Academic Fellow in 2011 and Senior Lecturer in 2015. His research area includes processing and analysis of the microstructures and properties of advanced materials with textured, nano and metastable structures, covering dielectrics, ferroelectrics, thermo electrics and ceramic-CNT composites.

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