Functional Thin Films and Surfaces
Room Golden State Ballroom - Session CP-ThP

Functional Thin Films and Surfaces (Symposium C) Poster Session

CP-ThP-1 Structural and Compositional Analysis of Titanium-Based PVD Coatings, ***Celia Rojo-Blanco***, Sheffield University, UK, Mexico; *J. Qi,* Sheffield University, UK, China; *G. Wu, L. Yang,* University of Leeds, UK, China; *S. Creasey-Gray, A. Leyland,* Sheffield University, UK

Novel Ti-Al-B and Ti-Al-B-N coatings have been deposited by plasma-assisted sputter PVD, with a view to constructing erosion-resistant metallic/ceramic multi-layered coatings for demanding environments of high humidity or temperature. Sample coatings of 1.2 to 1.6µm thickness were produced on both AISI 316 and Si-wafer substrates, and were studied using optical profilometry, XRD, SEM, TEM and EPMA to analyse their (nano)structure and chemical/phase composition.

TEM samples were prepared in both plan-view and cross-section. It was found that the coatings were constituted primarily of an amorphous solid solution with embedded nanocrystals – of either intermetallic (in the Ti-Al-B films), or boride/nitride (in the Ti-Al-B-N films) compounds. Clear TEM Electron Diffraction Patterns were not formed, even though we could observe some XRD reflections, indicating some degree of crystallisation within the coatings deposited.

it was also observed that the coatings contained a significant amount of oxygen 'contamination', distributed primarily at nanograin boundaries.

CP-ThP-3 Study of Spatial Distribution of Sputtered Al-Doped Zinc Oxide for Optoelectronic Applications, ***Eduard Llorens***, *E. Stamate,* DTU, Denmark

Transparent conducting oxides (TCOs) are needed for a wide range of applications in thin film devices such as thin film transistors, solar cells, and smart windows.

Tin doped indium oxide (ITO) is the most commonly used TCO material since it possesses high electrical conductivity and optical transmittance. Nevertheless, indium is scarce and expensive, hence, it would be desirable to find a cheaper and more abundant TCO material that could replace ITO. Aluminum doped zinc oxide (AZO) stands as one of the most suitable candidates due to its earth abundance, high stability, and non-toxicity. Despite its advantages, AZO suffers from low spatial uniformity when it is grown as a thin film using sputter deposition. This issue has been attributed to the bombardment of the film by high-energy negative oxygen ions generated at the sputter target and accelerated in the plasma region between the target and the substrate [1].

In this study, the spatial uniformity of the key properties of sputtered AZO films was studied as a function of the discharge type (DC, pulsed-DC, and RF), and sputtering parameters. A ceramic target containing 2 wt % of Al was used for all experiments. Usually, these kind of depositions are performed using rotation of the substrate to seek uniformity, in this study however, the rotation of the substrate was stopped for a better mechanism growth understanding, obtaining a thickness gradient.

Both pulsed-DC and RF discharges produced films possessing high electrical conductivity ($4x10^{-4}$ Ω.cm) and an average optical transmittance above 85% when the substrate temperature was above 100°C. All films deposited at room temperature presented lower electrical conductivity and lower transmittance. A DC discharge led to inferior film properties for TCO applications.

Films deposited at room temperature and using Pulsed-DC, and DC discharges showed an edge effect with an increase of the sheet resistance in the wafer region that is closer to the target, therefore, low distance from target to substrate (DTS). This undesirable characteristic was improved once the temperature of the substrate increased. Films deposited using RF discharge showed the best performance regarding optical and electrical properties.

[1] – K. Norrman, P. Norby and E. Stamate, J. Mater. Chem. C 10 (2022) 14353.

CP-ThP-4 Optical and Electrical Characterization of Thin NiO_x Films Obtained by R.F. Sputtering, ***Francisco David Mateos-Anzaldo***, *R. Nedev, E. Osorio-Urquizo, M. Curiel-Alvarez, O. Perez-Landeros, J. Castillo-Saenz,* Universidad Autónoma de Baja California, Instituto de Ingeniería, Mexico; *A. Arias-Leon,* Universidad Autónoma de Baja California, Facultad de Ingeniería Mexicali, Mexico; *B. Valdez-Salas,* Universidad Autónoma de Baja California, Instituto de Ingeniería, Mexico; *N. Nedev,* Universidad Autonoma de Baja California, Instituto de Ingeniería, Mexico

Thin NiO_x films were deposited on crystalline Si (c-Si) and corning glass by r.f. magnetron sputtering at temperatures in the range of 25–250 °C and powers in the range of 40–80 W. After the deposition, the films were thermally annealed at 450 °C to form nanocrystals. Ellipsometry measurements were used to determine the film thicknesses and the optical constants. The size of nanocrystals in annealed layers was evaluated by XRD measurements, while the surface roughness of the as-deposited and annealed films was measured by AFM. Metal/NiO_x/n–Si heterostuctures were prepared by deposition of thin NiO_x layers on n-type Si and evaporation of Au electrodes through a mask. The Au/NiO_x/c-Si structures were electrically characterized by current-voltage (I-V) and capacitance-voltage (C-V) measurements. The I-V dependences showed formation p-n heterojunction diodes with properties, which depend on the r.f. power, deposition temperature and annealing. The obtained results indicate that NiO_x films deposited at optimal conditions are promising for application in optical sensors.

CP-ThP-5 Deposition of Lanthanum-Doped Barium Stannate as Transparent conducting Oxides, *C. Liu, Y. Yan, S. Chen,* ***Yijia Chen***, *M. Wong,* National Dong Hwa University, Taiwan

The barium stannate ($BaSnO_3$, BSO) crystal has a perovskite structure, so as the lanthanum-doped barium stannate (LBSO). The LBSO thin film has high light transmittance and high electron mobility, and is considered potential candidate to replace the indium tin oxide (ITO) as conductive glass used for optoelectronics, because the indium in ITO is increasingly depleted in mineral resources and becomes ever expensive. We use the lanthanum metal target and the barium stannate target in the magnetron sputtering deposition system. The barium stannate is sputtered with 80W with radio frequency and lanthanum is sputtered with 10W DC. In the coated lanthanum-doped barium stannate film, a metal thin layer of pure lanthanum is intermittently deposited in between BSO layers to further improve the conductivity of the film. The transmittance of the coating shows periodical oscillation with the wavelength, which is typical of the consequence of interference phenomenon, signifying the flatness of the deposited film. After annealing at 600°C, crystallization occurs, as the x-ray diffraction analysis suggested. The concentration of La doping in the coating is about 10% of that of barium. According to Hall's measurement results, the multi-layerd LBSO coating with inserted La metal layer has a carrier concentration of $1.3x10^{22}/cm^3$ and a mobility of 177 cm^3/V s.

CP-ThP-6 Electrical Evaluation of Micro Water Droplets During Solidification Process Using Galvanic Array with Micro to Nano Gaps, ***K. Hirayama***, Chiba Institute of Technology, Japan; *M. Mekawy, J. Kawakita,* NIMS, Japan; *Y. Sakamoto,* Chiba Institute of Technology, Japan

Frost damage can be classified into two types: white frost, which occurs when water vapor sublimates on the surface of an object to form ice, and water frost, which occurs when water droplets condense and solidify. Currently, there are no excellent sensors that can detect frost, and frost can only be observed visually, which makes field observations difficult and makes the actual state of frost damage unresolved. The presenters have developed a sensor that can detect water and adsorbed water molecules by measuring the electric current that flows spontaneously due to galvanic action when an aggregate of water or adsorbed water molecules comes into contact with adjacent arrays of alternating thin wires made of different metals at regular intervals (minimum value 100 nm) on an insulating substrate. Previous results have shown that the current peaks appear before and after the water undergoes a supercooled state and solidifies, indicating that frost formation detection may be possible, and furthermore, the current peaks and microscopic solidification process have been clarified. As a response to water solidification, the current response is decreasing despite the growth of water droplets. The authors believe that the temperature dependence of the conductivity of water is responsible for the decrease in the current response. However, although the temperature dependence of conductivity in water has been clarified, the temperature dependence of conductivity in the supercooled state of water has not been clarified.

In this study, we aim to clarify the temperature dependence of conductivity in supercooled water by cooling the sensor surface temperature step by step from 0°C and by clarifying the sensor response behavior.

CP-ThP-7 Engineered Ionic Diode Membranes Based on Subnanochannel Metal-Organic Frameworks with High Space Charges for Boosted Lithium Ion Transport and Unprecedented Osmotic Energy Conversion in Organic Solution, ***Amalia Rizki Fauziah***, *L. Yeh,* National Taiwan University of Science and Technology, Taiwan

Harvesting the Gibbs free energy contained in the salinity gradient of waste organic solutions will not only relieve the environmental burden but also render a new clean energy resource to accomplish the never-ending energy demand. Taking inspiration from the electrocytes in the bioelectricity systems (e.g. electrical eel) which possess numerous subnanoscale rectified ion channels acting as an ion-selective filter allowing unidirectional ion transport, we sought a feasible strategy to design an ionic-diode membrane, ZIF-8/PSS@ANM, consisted of a continuous layer of the subnanochannel zeolitic imidazolate framework-8 (ZIF-8)/polystyrene sulfonate (PSS) and a highly ordered aluminum nanochannel membrane (ANM), as osmotic energy conversion generator. The SEM results indicate that a large-scale, continuous, defect-free ZIF-8/PSS membrane was successfully prepared. Furthermore, the BET result verifies that the as-synthesized MOF membrane possesses subnanoscale (~4.1 Å) channel windows with a high surface area (~1290 m^2/g). The as-developed ZIF-8/PSS_2@ANM demonstrates a vivid diode-like ion current rectification effect even in methanol solutions with a ratio as high as ~5.57 in 1 mM LiCl (Fig. 1a), enabling the ion transport magnification at the subnanoscale confinement, due to the multiple broken symmetries (Fig. 1b). We, thereby, probe the application of this subnanoscale ionic-diode membrane in osmotic energy conversion, and exceptionally, an unprecedented osmotic power density of ~5.28 W/m^2 at 50-fold LiCl gradient in methanol was achieved (Fig. 2a), exceeding the bandgap of commercial benchmark value. The unbelievable osmotic power achieved can be plausibly elucidated to be associated with the space charges carried by PSS enhancing the ionic selectivity and accelerating ion migration, abundant ordered subnanoscale window-cavity channels of the ZIF-8 for screening dehydrated cations (Fig. 2b), and ionic-diode effect for amplifying the generated ionic current. The heterogeneous subnanochannel MOF membrane we designed will likely ignite valuable insight not only to help alleviate the environmental burden but also to open up a new avenue towards a new energy platform for meeting the need of the ever-growing energy demand.

CP-ThP-8 Designing Experimental Determination of Sheet Resistance of a Titanium Self-Aligned Silicide Formation, ***Jau-Shiung Fang***, *Y. Chang, Y. Kuo,* National Formosa University, Taiwan

In recent years, metal silicides have been widely used in ultra-large scale integrated-circuit (ULSI). Shallow junction generation has always been a major challenge with ever-shrinking device dimensions, and size effects must be overcome for silicide generation, thermal stability, and electrical properties. Due to the size effects, evolution of metal silicides from $TiSi_2$, $CoSi_2$, to NiSi has been used as the source material for the formation of a low-resistivity form of metal silicide on top of the gate and source/drain for connecting the tungsten contact plug. However, characteristics of $TiSi_2$ have led to it having the potential to be a plug/interconnect material in nanoscale devices.

Because the $TiSi_2$ used in logic device is normally fabricated using a self-alignment silicide process, the process includes Ti/TiN deposition, first-step rapid thermal annealing (RTP-1), strip of unreacted Ti/TiN, second-step rapid thermal annealing (RTP-2), and final-step annealing for smoothing the top-cap dielectric. The process needs to be optimized using a design of experiment method. The influence of arsenic doping dosage, the thickness of titanium, the temperature of rapid thermal annealing on the sheet resistance of a polysilicon gate was experimentally analyzed. Experimental results revealed that thickness of titanium, the temperature of RTP-2, and the interaction between the thickness of titanium and the temperature of RTP-2dominated the sheet resistance of $TiSi_2$. An optimum RTP-2 temperature was also required for reducing sheet resistance of $TiSi_2$. A low sheet resistance was yielded for titanium thickness = 32-35 nm, RTP-1 = 720-750°C for 75 sec, and RTP-2 = 860°C for 20 sec. Heavily doping of the polysilicon gate with arsenic suppressed the formation of C54-$TiSi_2$. The lowest sheet resistance of 3.91 Ω/sq. was obtained with an arsenic dosage of $1´10^{14}$ $/cm^2$. The characteristics of the $TiSi_2$ supports its capability as a contact material for next generation devices.

Keywords: Titanium self-aligned silicide, $TiSi_2$, Sheet resistance, Designing experimental

CP-ThP-9 Hybrid Structures of p-n junction for Improving Efficiency of Photovoltaic Devices, ***Paweł Jarka***, *T. Tański,* Department of Engineering Materials and Biomaterials, Faculty of Mechanical Engineering, Silesian University of Technology, Poland*; B. Hajduk, H. Bednarski,* Centre of Polymer and Carbon Materials, Polish Academy of Sciences, Poland

The article describes the study of electrical properties investigations of solar cells based on organic p-n junction. Organic layer systems will be produced using spin-coating method with starting material in form of mixture of polymeric materials: Poly[2,6-(4,4-bis-(2-ethylhexyl)-4Hcyclopenta[2,1-b;3,4-b']dithiophene)-alt-4,7(2, 1,3-benzothiadiazole)] - PCPDDTBT) and poly[2,5-bis(2-octyldodecyl)pyrrolo[3,4-c]pyrrole-1,4(2H,5H)-dione-3,6-diyl)-alt-(2.2';5',2'';5'',2'''-quaterthiophene-5.5'''-diyl)] - DPP4T. The p-n heterojunction materials were selected on the basis of gap matching component acting as an electron donor to a wavelength of 700 nm, corresponding to the maximum photon density in the spectrum of sunlight (about 1.8 eV) to the acceptor material. Acceptor material was selected on the basis of the band gap width and the electron affinity energyionization energies suitably greater than the electron affinity of the excited state of the donor, and ionization potential, ensuring dissociation of the exciton and transfer of the electron from the LUMO orbital of the donor into the LUMO orbital of the acceptor. The investigations presented in article included the production of organic solar cells (OSC) with bulk heterojunction (BHj) and determination ofthe structure and morphology of the deposition layers, chemical composition analizses, optical and electrical properties of the BHj thin films and I–V characteristics of created OSC using PV Test Solar Cell I–V Tracer System and Keithley 2410 source meter under Standard Test Conditions (AM 1.5, 100 W/m2). The conducted basic research brings knowledge of controlling the structure and properties of the thin films of the semiconducting organic material (containing bulk heterojunctions). Analysis of the results of electrical properties testing will allow for a thorough examination mechanisms of electronic transitions, electron-electron and electron-phonon interactions in p-n heterojunctions combining organic materials.

CP-ThP-10 The Investigation of Electro-Optical Properties of Hybrid Organic-Inorganic Thin Films, ***Tomasz Tański***, Department of Engineering Materials and Biomaterials, Faculty of Mechanical Engineering, Silesian University of Technology, Poland

The aim of researchis to present influence of phase composition and manufacturing parameters on structure and electro-optical properties and surface morphology of hybrid nanocomposite thin films. The hybrid organic-inorganic material constitute thin layer of a nanocomposite with a polymer semiconductor matrix and reinforcement of semiconductor nanoparticles. The DPP4T polymer, Poly [2,5-bis (2-octyldodecyl) pyrrolo [3,4-c] pyrrole-1,4 (2H, 5H) -dione -3,6-diyl) -alt- was chosen as the matrix material (2,2 '; 5', 2 ''; 5 '', 2 '' - quaterthiophen-5,5 '' - diyl)] due to its narrow optical band gap and high charge-carrier mobility, as reinforcement were selected TiO2 and ZnO nanoparticles (NPs) with a wider band gap, however ensuring high electrical stability of the inorganic semiconductor - polymer system. Such a hybrid combination of materials has a very perspective application in electronics, with particular emphasis on optoelectronics and photovoltaics. Thin films ofDPP4T / NPs were deposited using spin-coating simple and fast method from solution. The spin-coating processes were carried out with the use of variable deposition conditions, from the point of view of the starting material and using different technological conditions.

In order to identify the structure (with particular emphasis on arrangement of the reinforcing phase) and surface morphology of thin films the Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM) were used. Chemical composition analysis was performer with use X-ray powder diffraction (XRD), energy-dispersive X-ray spectroscopy (EDS) and Fourier-Transform Infrared Spectroscopy (FTIR)

Opto-electrical properties have been performer by UV-Vis absorption spectroscopy and elypsometry. Based on the analysis of the measurement results of produced nanomaterials, the energy band gap (Eg) for the materials, the refractive index, the extinction coefficient, the real and imaginary part of the dielectric constant will be determined. The equivalent electric model of the thin films was determined by impedance spectroscopy (EIS).

The results of the work indicate that the application of the developed thin layers may be a promising solution in optoelectonics and photovoltaics (especially in thin-film heterojunction systems) due to the optical and

electronic properties obtained, as well as the speed and simplicity of application.

CP-ThP-11 Multilayer Growth of 2D Layered Material Bi_2Se_3 Through Heteroatom-Assisted Step-Edge Barrier Reduction, ***Namdong Kim***, Pohang Accelerator Laboratory, Republic of Korea

Various two-dimensional (2D) van der Waals systems including graphene, hBN, MoS_2, WS_2, and topological insulators form heterostructures with the high quality in atomic-layer scale. Understanding the growth kinetics of the layered heterostructure films is essential to control the atomic layer growth. We studied the growth kinetics of Bi_2Se_3 film on graphene by using AFM images and DFT calculations as well as by in-situ x-ray scattering.

During growth of 2D materials, abrupt growth of multilayers is practically unavoidable even under well-control. Delicate control of growth reaches its limits for complicated crystal structure. In epitaxial growth of Bi_2Se_3 thin film, we observe that the multilayer growth pattern deduced from in-situ x-ray diffraction requires nontrivial interlayer diffusion process. We expect that an intriguing diffusion process occurs at step edges where a slowly downward-diffusing Se adatom having a high step-edge barrier interacts with a Bi adatom pre-existing at step edges. The Se–Bi interaction lowers the high step-edge barrier of Se adatoms. This drastic reduction of the overall step-edge barrier and hence increased interlayer diffusion modifies the overall growth significantly. Thus, a step-edge-barrier reduction mechanism assisted by hetero adatom-adatom interaction could be widely utilized for multilayer growth of 2D heteroatomic materials.

KEYWORDS: heteroatom epitaxial growth, kinetic multilayer growth model, step-edge barrier

CP-ThP-12 Metallic Ground States of Strained Ti_2O_3 Thin Films, ***Heungsoo Kim***, *S. Mathews, E. Lock, J. Prestigiacomo,* Naval Research Laboratory, USA*; M. Qazilbash,* William and Mary University, USA*; A. Piqué,* Naval Research Laboratory, USA

Single crystal Ti_2O_3 with a trigonal corundum structure exhibits a metal to insulator transition (MIT) between 400K and 500K without a structural phase transition. Upon cooling Ti_2O_3 undergoes a transition from metallic state to a nonmagnetic insulating state showing a ultranarrow bandgap (~0.1eV). Compared to other MIT oxides such as V_2O_3 and VO_2 that undergoes structural phase transition during MIT, the Ti_2O_3 shows pure electronic MIT process without having a structural transition. This purely electronic MIT is unique and would be useful for many electronic and photonic devices. We have deposited epitaxial corundum structured Ti_2O_3 films on c-plane sapphire substrates using pulsed laser deposition and investigated their structural, electrical, and optical properties as a function of the film growth parameters. We have found that a MIT temperature is varied with a growth temperature and the MIT is suppressed when the films are grown at 480 °C, showing conducting behavior at all temperatures. This metallic ground states were further investigated by X-ray diffraction and spectroscopic ellipsometry measurements to provide crystal structure and broadband optical properties of Ti_2O_3 films. Results show that the electrical properties are governed by the lattice parameter ratio(c/a) of crystal structure and the imposed strain causes an increase in the c-axis length as the temperature is decreased, and thereby suppresses the MIT. We will present details of the deposition conditions on the structural, electronic, and optical properties of Ti_2O_3 films.

This work was supported by the Office of Naval Research (ONR) through the Naval Research Laboratory basic research program.

CP-ThP-14 Rapid Thermal Annealing and Structural Evolution of Sputter-Deposited AlScN Thin Films, ***Hongfei Liu***, *A. Yong, N. Gong, R. Karyappa, T. Meng,* Institute of Materials Research and Engineering (IMRE), Singapore

The excellent chemical and mechanical stability, the excellent piezoelectrical properties, as well as the semiconductor compatibility, not only in thin film deposition but also in device processing, of AlN made it widely used in various piezoelectric applications. Recent studies revealed that incorporation of Sc with proper composition to substitutionally replacing Al in the lattice of AlN could dramatically increase its piezoelectric coefficient and electromechanical coupling. The presence of polarity inversion domains in III-nitride could negatively affect the piezoelectric coefficient. In fact, polar-controlled growth has long been studied in III-nitride thin films and heterostructures, e.g., to enhance carrier injections in GaInN/GaN multiple quantum well structures. Post-growth thermal annealing has also been found to reduce the density of polarity inversion domains in III-nitride thin films.

In this work, we have studied the effect of rapid thermal annealing (at T_{ann} = 600-900 °C)on surface chemical and structural evolutions of fiber-textured AlScN thin films deposited on Si (111) substrate by magnetron-sputtering. The film thickness was controlled at 1.0 µm and the Sc composition was controlled at about 15%. By varying the annealing time t_{ann} in periodic cycles from 3 to 48 min, we found that the lattice constant along the (0001) direction tends to be increased, along with a peak splitting of the X-ray diffraction (XRD) peak around the (0002) atomic planes. In this post, we will be presenting the experimental results.

CP-ThP-15 Work Function Enhancement of WO_3 Filamentous Films Obtained by Resistive Heating Evaporation Technique, ***Fabien Sanchez***, *L. Marot, R. Antunes, R. Steiner, E. Meyer,* University of Basel, Switzerland

Tungsten trioxide (WO_3) films are of great interest due to their electronic properties, which can be tuned by surface nanostructuring leading to enhanced efficiency for gas sensing, energy storage or electrochromic applications. Resistive heating of tungsten (W) filaments at pressures of few Pa in an oxygen O_2 atmosphere has already demonstrated its capability to form porous, micro/nano-structured, cheap and fast films making it suitable for industrial applications.

In this work, stoichiometric WO_3 films were produced by applying a current into a W filament in an O_2 atmosphere. The pressures were varied from 2 to 20 Pa. The increase of the pressure above 7.5 Pa led to amorphous WO_3 films with a filamentous morphology. As a function of the pressure, the film morphology and the work functions (W_F) were analyzed using Scanning Electron Microscopy (SEM) and in-situ Ultraviolet Photoelectron Spectroscopy (UPS). In addition to the high surface-to-volume ratio of the films, the W_F exhibited an increase from 5.8 eV, for a conventional WO_3 film, to a maximum of 8.7 eV at 20 Pa. This change corresponds to an increase of the W_F of about 50 %, making our films suitable for a large variety of applications.

CP-ThP-17 Controlled Thermal Conduction-based Detection of Dew Condensation on Target Solid Surface by Galvanic Arrays Sensor Chip, ***K. Iida***, Chiba Institute of Technology, Japan*; M. Mekawy, N. satoh, J. Kawakita,* NIMS (National Institute for Materials Science), Japan*; Y. Sakamoto,* Chiba Institute of Technology, Japan

Reliable early detection of dew condensation is considered a bottleneck in surface protection against numerous negative effects such as surface fogging and corrosion. To detect the early stage of dew condensation, we fabricated a thin film-based sensor chip composed of a confined silica surface between two adjacent interdigitated gold and aluminum metal arrays that are arranged alternately at regular intervals varied between 0.5 to 10 mm. Whenever a tiny droplet is bridging between these arrays, a passage of galvanic current could be reliably detected. Imitating the surface condition for dew condensation was carried out in a temperature-controlled scheme employing thermal conduction heat transfer between the solid surfaces of the sensor chip and its contacting heat conductor. However, the effect of the geometrical shape of the heat conductor on the thermal heat conduction rate is yet to be emphasized. In this study, three different fabricated geometrical shapes of aluminum heat conductors (Fig. 1(a)) were attached to the back side of sensor chip and used for a step-wise (static) or direct (dynamic) temperature-cooling heat transfer mechanisms (Fig. 1(b)). The experimental results revealed that the sensor response current (as a measure of dew condensation detection) increased when the sensor surface temperature was dropped below the dew point. Moreover, the rate of thermal conduction was larger at direct temperature-cooling mechanism than at step-wise mechanism as shown in Fig.2. In addition, the temperature difference between the senor surface and each heat conductor was found to follow the order of $DT_I > DT_{II} > DT_{III}$. Furthermore, the rate of thermal conduction between the thermally contacted surfaces of sensor and each heat conductor was found to follow the order of I < II < III. This could be attributed to the thermal resistivity of each examined heat conductor which followed the order of $R_I > R_{II} > R_{III}$ (listed in table 1). The results were in an agreement with further simulation-based investigations that were also performed to correlate the geometrical shape of contacting heat conductorwith its heat transfer to the sensor surface.These results demonstrated that controlling the temperature of the sensor surface depends on the geometrical shape and the temperature change of its contacting heat conductor. Therefore, it can be concluded that our developed sensor can be beneficially used for the enhanced early detection of dew condensation at the solid substrate surfaces of interest employing the thermal conduction heat transfer mechanism.

CP-ThP-18 Polyimide-Based Gate Dielectrics for High-Performance Organic Thin Film Transistors, ***Yan-Ting Chen***, *Y. Yu,* Ming Chi University of Technology, Taiwan

In this study, TiO2-SiO2 nanoparticles with OH group on their surface will be prepared by sol-gel process from TEOS and titanium ethoxide. The particle size and morphology, crystal phase, crystallinity, and the corresponding dielectric constants are investigated. The prepared ST colloids will further react with the fluorine-containing soluble polyimide with side OH group chains to form the PI/ST hybrid thick films on glass and flexible plastic substrate. The prepared high dielectric PI/ST films will be applied to fabricate the high capacitance memory devices with structure Al/PI-ST/ITO-Glass or Al/PI-ST/ITO-PET .The PI/BT films will further be applied to fabricate the OFETs with structure Al/ PffBT4T-2OD /PI-ST/Si on the silicon substrate with the PI/ST hybrid film as the gate insulator. We have systematically investigated the effects of properties of PI/ST films such as dielectric constant, surface roughness, and thickness on capacitance, field-effect charge mobility, on/off ratio, threshold voltage, and leakage current.

CP-ThP-19 Epitaxially Grown Gold (100) Surfaces for Oxygen Reduction Reactions, ***Katharina Kohlmann***, *D. Guay,* Institut national de la recherche scientifique, Canada; *A. Sarkissian,* Plasmionique Inc., Canada; *C. Schindler,* Munich University of Applied Sciences, Germany; *A. Rüdiger,* Institut national de la recherche scientifique, Canada

Noble metals have long been known to be an excellent basis for electrocatalysts. While the effectivity of catalysts depends on the reaction they are used for, studies have shown that for the oxygen reduction reaction (ORR), Au (100) is the most active face of Au in alkaline media. This work investigates magnetron sputtered epitaxial Au-films on MgO (100) for electrocatalysis. We show that the deposition parameters and their effect on the surface morphology are a key factor to optimize catalytic activity. We further explore various surface treatment methods to improve the adhesion of Au as well as its surface morphology without the use of a transition metal seed layer. The samples are characterized by atomic force microscopy, X-ray diffraction and cyclic voltammetry to establish a correlation between the surface topography and electrocatalytic activity.

CP-ThP-20 Ion-Selective Capacitive Deionization of Saltwater Using Functionalized Graphene Thin-Film Coated Electrodes, *H. Cheng,* National Cheng Kung University, Taiwan; *J. Wang,* Stanford University, USA; ***Hong Paul Wang***, National Cheng Kung University, Taiwan

Drinking water shortage is getting worse in recent decades. Desalination of saltwater by capacitive deionization (CDI) with the advantages of relatively low energy consumption and environmental friendly is of increasing importance. To improve the desalination performances, by introducing ion exchange membranes (IEM) on the surfaces of CDI electrodes for weakening co-ion repulsion effect, membrane CDI (MCDI) cell architectures have been constructed. Nevertheless, IEM may suffer from high cost and interfacial resistance. It would be economically attractive to use IEM for selectively moving relatively ions to electrodes for better desalination performances and higher feed rates. Thus, in the present work,sulfonated- and poly(diallyldimethylammonium chloride)-functionalized graphene oxide (SGO and PGO) serves as hydrophilic cation- and anion-exchange membrane (CEM and AEM), respectively to enhance CDI efficiencies. The positively charged PGO thin-film coated on the activated carbon (AC) can selectively transport anions to positive electrodes in the CDI process. The SGO and PGO coated AC electrode pair (AC/SGO ‖ PGO/AC) for CDI of saltwater ([NaCl]=200-500 ppm) under +1.2 V for 1 h reaches a highoptimized salt removal (200 mg/g·day) and electrosorption capacity (9 mg/g). In the reverse voltage desorption operation mode, effective desorption of anions for regeneration with the thin-films can also be achieved. This work presents the feasibility using the high-efficiency, low-cost and facile SGO and PGO ion-selective thin-film coated on AC electrodes to enhance desalination performances.

CP-ThP-21 Research on the Application of the Double-layer Hole Transport Layer of Novel Functional Organic Small Molecule Materials in High-efficiency Inverted-Perovskite Solar Cells, ***Wei-En Wu***, *Y. Yu,* Ming Chi University of Technology, Taiwan

This research is divided into two parts. Both use the hydrophobic small molecule as a double-layer hole transport material provided by Professor Yung-Chung Chen from Kaohsiung University of Science and Technology. In the first part, we investigate the effects of the three p-type small molecules (CL-1~CL3) with tetraphenylethylene as the core and different aromatic rings attached to the side chain. The side chains are benzene, naphthalene, and pyrene. The tetraphenylethylene core has highly distorted nature, even without alkyl solubilizing groups, it can still have good solubility, and then through the modification of side chain groups, the energy level and hole mobility can be fine-tuned. Under the condition of AM1.5, NiOX/ CL-3 double-layer hole transport layer has the best power conversion efficiency of 20.15% in the trans-structured perovskite solar cell.

CP-ThP-22 High-Performance non-Fullerene Systems for Organic Solar Cells, ***Chun-Chieh Lee***, *Y. Yu,* Ming Chi University of Technology, Taiwan

For the organic photovoltaics (OPVs), the choice of solvent affects the morphology of the active layer blend as well as the device performance and potential commercial applications. In this study, two different solvents, chloroform (CF) and chlorobenzene (CB) with optimal process parameters, were applied to prepare the OPVs with the PM6:BTP-eC9 as the active layer. Atomic force microscopy and grazing-incidence wide-angle X-ray scattering were used to evaluate the blend morphologies of the OPVs, and also examined the optoelectronic properties of the blend films and devices. The power conversion efficiencies could reach up to 17.82% when using CB as the solvent, without any additives. Compared with the CF-based device, the optimized CB-derived OPV exhibited a more suitable phase-segregated domain size with stronger face-on molecular stacking, leading to more efficient carrier transport. Thus, by optimizing the fabrication conditions and selecting a suitable solvent that could improve the the structure of the PM6:BTP-eC9 blend films and thus also improve the OPV performance.

CP-ThP-23 Vanadium Doped Zno Nanorod Array Piezoelectric Pressure Sensor, ***Shu-Yu Lin***, *J. Huang, S. Brahma,* National Cheng Kung University (NCKU), Taiwan

ZnO has semi-conductivity and piezoelectricity at the same time that makes it a promising material for piezotronics. Zinc Oxide (ZnO) nanorod array was grown on silicon substrates by a hydrothermal method. From SEM top-view image, well aligned ZnO nanorods were deposited on the silicon substrate. The XRD patterns showed that the nanorods behaved highly (002) oriented. Resonant Raman spectroscopy revealed that the degree of (002) orientation was decreasing with raising the vanadium concentration of growth solution. The Photoluminescence spectrum showed typical ZnO UV emission and the 6% sample has an obvious red shift.

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