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

Functional Thin Films and Surfaces Poster Session

MB-ThP-1 Improved Energy Storage Features in Atomic Layer Deposition Tailored Nickel Oxide on Phosphorous Doped MnO_2 Core-Shell Configuration, *Sangeeta Adhikari,* Vellore Institute of Technology, India; ***Do Heyoung kim [kdhh@chonnam.ac.kr]***, Chonnam National University, Republic of Korea

An innovative method was employed to synthesize ultrathin NiO on phosphorus-doped MnO_2 nanosheets, utilizing a straightforward hydrothermal process to produce a Mn precursor on Ni-foam, subsequently enhanced by phosphorus doping through a basic solid-state annealing procedure and ALD technique. The effect of phosphorus doping was examined by varying the annealing temperature, resulting in a significant increase in oxygen vacancies and electrochemical performance. Furthermore, the atomic layer deposition of NiO improved electrochemical performance while ensuring cycling stability without disturbing the system. Modifying the thickness of NiO thin films on phosphorus-doped MnO2 led to a notable enhancement in electrochemical performance, as shown by the performance of the solid-state asymmetric device. This integrated approach is expected to aid in creating novel electrode materials for high-performance supercapacitors through the application of electroactive metal oxides using ALD coating.

MB-ThP-2 Scalable Surface Engineering of PDMS for Uniform Inkjet-Printed Silver Patterns, ***Hsuan-Ling Kao [snoopy@mail.cgu.edu.tw]***, Chang Gung University, Taiwan; *Li-Chun Chang,* Ming Chi University of Technology, Taiwan; *Min-Hsuan Lu,* Chang Gung University, Taiwan

The advancement of flexible and wearable electronics has increased the demand for materials compatible with the human body. Polydimethylsiloxane (PDMS) stands out due to its biocompatibility, transparency, chemical stability, and skin-like mechanical properties, making it suitable for bio-integrated devices. Its elastomeric nature also allows conformal contact with curved surfaces, making it suitable for epidermal and implantable electronics. Despite these advantages, achieving reliable inkjet printing of conductive traces on PDMS remains challenging due to poor ink adhesion and inconsistent droplet behavior. This study introduces a scalable surface modification approach using dielectric barrier discharge (DBD) plasma to improve PDMS wettability for inkjet printing of silver nanoparticle films. The DBD plasma treatment was performed under ambient conditions, and the discharge parameters were tuned to ensure uniform activation across the entire surface. The optimized argon flow rate and electrode gap facilitated consistent plasma exposure, resulting in reproducible surface energy enhancement. By optimizing argon flow and electrode-substrate distance, the treated area was expanded to 5 × 5 cm^2. Water contact angle (WCA) measurements across nine points confirmed uniformity, averaging 50° ± 1.8°, and white-light interferometry verified the surface remained undamaged. Substrate temperature was also found to play a role comparable to WCA in determining film quality, particularly in relation to printed pattern dimensions. At 50 °C, 200 µm-wide lines printed with three layers exhibited slight wrinkling or cracking, while 300 µm-wide lines showed minor edge spreading. Four-layer prints at this temperature led to bulging. At 60 °C, three- and four-layer 200 µm-wide lines suffered from severe wrinkling and cracking, while 300 µm-wide lines showed edge drying or bulging in three layers, and slight bulging in four layers. An appropriate substrate temperature was identified as essential, enabling both 200 µm and 300 µm-wide silver lines to maintain structural integrity and electrical performance across three to four printed layers. Under these optimized conditions, 300 µm-wide, 4 cm-long silver transmission lines exhibited excellent conductivity with low insertion loss. These results demonstrate the effectiveness of the proposed surface engineering and printing strategy for enabling high-quality, large-area conductive patterns on PDMS, supporting the development of next-generation bio-integrated electronic systems.

MB-ThP-3 Hydrogen-Induced Defect Formation in Yttrium-Based Coatings for Dry Etching Processes, ***Jiyeon Baek [jy.baek@samsung.com]***, *Jinsoo Jung, Taeyoon Park, Jinho Jo, Jaebum Sung, Yongjoon Cheong, Youngjune Park, Woohyung Kim, Seokmin Yoon,* Samsung Electronics, Republic of Korea

As the critical dimensions of semiconductor devices shrink, especially for the sub-3nm node, dry etching processes increasingly employ complex hydrogen-containing plasma mixtures to achieve precise pattern control. Hydrogen plasma exposure can induce degradation of chamber coatings and the formation of yttrium-based particle defects, resulting in significant yield loss. This study investigates the material properties and microstructural design strategies of yttrium-based coatings to enhance hydrogen resistance and process stability. Hydrogen-induced defect formation was modeled as a function of materials phase and deposition conditions, and correlations between microstructural characteristics and plasma-induced degradation were evaluated. From a materials perspective, Y_2O_3 and $Y_3Al_5O_{12}$ (YAG) coatings were experimentally assessed. Regarding deposition methods, commonly employed plasma-resistant coating techniques, including plasma spraying, aerosol deposition (AD), and physical vapor deposition (PVD), were systematically reviewed. Exposure to hydrogen-rich plasma revealed hydroxide formation, approximately 20nm in thickness, on Y_2O_3 grains, while no transformation to a new crystalline phase was observed on YAG grains, as confirmed by crystallographic analysis. Concurrently, microstructural evaluation demonstrated that PVD coatings minimize pores and reactive species diffusion paths, effectively mitigating plasma-induced degradation. These observations confirm that PVD YAG is a promising candidate for suppressing hydrogen-induced particle formation and enhancing the durability of etch chamber components in sub-3nm node dry etching processes. The results provide a mechanistic understanding of hydrogen plasma–coating interactions and strategies for the optimized design of plasma-resistant chamber coatings.

MB-ThP-4 Spatially Resolved Molecular Arrangement on the Surface of PEDOT:PSS Film via Laser Scanning, *Chanwoo Kim,* ***Habeom Lee [hblee@pusan.ac.kr]***, Pusan National University, Republic of Korea

Conjugated polymers, particularly poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS), are extensively studied for their intriguing electronic and optical properties, making them promising candidates for various functional applications. Precise and spatially resolved control over their molecular organization and morphology is one of challenging things for the tailored innovations. Here, we present a comprehensive investigation into the localized and spatially precise surface structural reorganization of PEDOT:PSS films, achieved through Laser-induced photo thermal effect without any chemical agents. Our focus is on delineating the intricate morphological and molecular changes and understanding the underlying mechanism that enables this spatial control.

Our study delineates the morphological evolution on surface of PEDOT:PSS films (~ 10 µm thickness) under varying laser doses (wavelength: 532 nm, spot size: 7 µm, continuous wave). Notably, a moderate laser dose induces significant morphological transformations, including undulating and dome-like micro-scale surface features with color change. Critically, the moving continuous laser induces a localized thermal distribution. This consistent thermal propagation, coupled with the kinetic state of the laser, induces a rearrangement within the PEDOT:PSS molecular system. The evidenced AFM phase images exhibit a distinct geometry, providing direct visual evidence of spatially controlled molecular reorganization on the surface. These observations promise a powerful approach for achieving spatially resolved control over molecular arrangement, enabling precise patterning and local property tuning.

Further characterization using XPS, UV-Vis, AFM, XRD, Raman, and FT-IR spectroscopy provides insights into the mechanisms driving these changes. This comprehensive study not only significantly elucidates fundamental understanding of laser-PEDOT:PSS interactions for functional film design but also suggests the intricate potential of this technique for creating advanced functional surfaces with tailored properties through precisely engineered molecular architectures.

MB-ThP-5 Influence of the Si Alloying on the Growth Stability and Electrical Properties of AlN Thin Films, ***Norma Salvadores Farran [norma.salvadores@tuwien.ac.at]***, *Tomasz Wojcik,* TU Wien, Austria; *Astrid Gies, Jürgen Ramm, Klaus Böbel,* Oerlikon Balzers, Liechtenstein; *Szilard Kolozsvári, Peter Polcik,* Plansee Composite Materials, Austria; *Tobias Huber, Jürgen Fleig, Helmut Riedl,* TU Wien, Austria

Aluminum nitride-based ceramics are well known for their insulating properties combined with high thermal conductivity. Their range of applications is wide, in both structural components and thin films. However, the electrical conductivity of these materials is highly temperature-dependent. As the temperature increases, the mobility of charge carriers also rises, which poses significant challenges to their insulating performance.

This study investigates the growth of insulating AlSiN thin films using physical vapor deposition (PVD) and evaluates their electrical insulation at temperatures up to 750 °C. Various reactive PVD techniques were explored, including high-power impulse magnetron sputtering (HiPIMS) and bipolar pulsed sputtering. All depositions utilized a 3-inch aluminum target with varying silicon concentrations in an Argon/Nitrogen (Ar/N_2) atmosphere. Depending on the silicon content, either hexagonal AlN films containing an amorphous Si_3N_4 phase or fully amorphous AlSiN films were produced. The target's alloying concept was designed to enhance deposition stability during sputtering. Within this framework, we also investigated the formation of a fully nitride film at lower reactive gas ratios while maintaining excellent electrical insulating properties.

Phase formation has been examined using X-ray diffraction (XRD), while the deposition rate and film morphology were characterized by scanning electron microscopy (SEM). The insulating behavior of the coatings was evaluated via in-situ impedance spectroscopy across a temperature range from 300°C to 750°C, using Ti/Pt lithography pads as electrodes.

The electrical properties are related to the morphology of the films, particularly whether the films were crystalline or amorphous. Additionally, the influence of impurities, such as O_2, plays a significant role in reducing the insulating properties of the films.

MB-ThP-6 Ag-Modified Bi2Se3 Nanoplatelets with Enhanced UV–Visible Photodetection, ***Chih-Chiang Wang [wilbur0913@gmail.com]***, National Yunlin University of Science and Technology, Taiwan*; An-Ya Lo,* National Taiwan Normal University, Taiwan

Bi_2Se_3 has emerged as a promising candidate for photodetector applications due to its narrow band gap (~0.35 eV), conductive surface states, and insulating bulk properties. In this study, Bi_2Se_3 nanoplatelets were synthesized on Al_2O_3(100) substrates via thermal evaporation, followed by Ag deposition using the magnetron sputtering technique. The rhombohedral crystal structure of Bi_2Se_3 was confirmed by XRD, HRTEM, Raman spectroscopy, and XPS analyses. The presence and distribution of Ag on the Bi_2Se_3 surface were further verified by FESEM–EDS, XPS, and HRTEM. Optical measurements revealed that the UV–visible absorptance of Bi_2Se_3 nanoplatelets decreased when the Ag content exceeded 7.1 at.%. However, photocurrent responses under zero bias were significantly enhanced by the introduction of Ag. Specifically, the Bi_2Se_3 nanoplatelets containing 7.1 at.% Ag exhibited photocurrents approximately 4.3 and 4.6 times higher than those of pristine Bi_2Se_3 under UV and visible light, respectively. This enhancement is attributed to (i) the intrinsic narrow band gap of Bi_2Se_3, (ii) the formation of a Schottky field at the Ag/Bi_2Se_3 interface, (iii) the LSPR effect of Ag, and (iv) the improved surface conductivity at the heterointerface. These findings demonstrate that optimized Ag deposition can effectively enhance the photosensitivity of Bi_2Se_3 nanoplatelets, highlighting their potential for broadband photodetector applications.

MB-ThP-7 Tailoring Nanometric Vanadium Dioxide Morphology to Tune Thermochromic Optical Properties, ***Asma Banshamlan [asma.banshamlan@univ-st-etienne.fr]***, *Hai Hoang Thi Thanh, Florent Bourquard, Anne-Sophie Loir, Yannick Bleu, Yaya Lefkir, Christophe Donnet, Florence Garrelie, Lilian Bossuet,* Université Jean Monnet Saint-Étienne, CNRS, Institut d'Optique Graduate School, Laboratoire Hubert Curien, UMR 5516, F-42023 Saint-Etienne, France

Vanadium dioxide (VO_2) thin films are highly attractive for optical coatings and photonic devices due to their reversible metal-insulator transition (MIT) near 68 °C, which produces a sharp change in optical properties. Controlling the MIT through thin-film processing and morphology is critical for achieving tunable infrared functionality.

Amorphous VO_x layers with thicknesses of 50 - 200 nm were deposited by pulsed laser deposition (PLD) from a V_2O_5 target onto glass substrates, followed by rapid thermal annealing (RTA) at 400 °C for 15 - 120 s in oxygen. Structural and optical responses were characterized using grazing-incidence XRD, Raman spectroscopy, SEM, and UV-Vis spectroscopy.

All films exhibited dewetting, with morphology strongly dependent on initial thickness. Thinner films formed dense, uniform nanoparticles, while thicker films developed larger, less homogeneous features. These differences directly affected the MIT-driven optical response: plasmonic resonances red-shifted with increasing feature size, enabling selective infrared modulation. In contrast to more complex nanoparticle fabrication methods, this simple approach provides precise control over mean particle size, and the plasmonic response is highly sensitive even without monodispersity or long-range ordering.

These results demonstrate that thickness-dependent dewetting can be harnessed to design VO_2 thin-film coatings with tunable, wavelength-selective optical properties.

MB-ThP-8 Different Morphologies of Gallium Oxide Thin Films Fabricated by Liquid-Target Reactive DC-Pulsed Magnetron Sputtering, ***Jan Koloros [koloros@ntis.zcu.cz]***, *Petr Novák, Sayed Alireza Ataie, Jiří Rezek, Radomír Čerstvý, Pavel Baroch,* University of West Bohemia in Pilsen, Czechia

Gallium oxide (Ga_2O_3) remains a focus of research due to its outstanding optoelectronic properties, including an ultra-wide bandgap of approximately 4.8 eV, a high electron saturation velocity, and its ability to withstand a high breakdown electric field of about 8 MV/cm. Although Ga_2O_3 is typically prepared using methods such as MBE, MOCVD, or ALD, it would be advantageous to find a viable method for preparing this material using magnetron sputtering as well. This is because this method is known for its high deposition and ease of up-scaling the process. Despite some published work in this area, it has not yet been possible to find conditions that lead to layers with satisfactory electrical properties.

In this work, we focus on reactive magnetron sputtering of Ga_2O_3 films using a liquid gallium metal target on different substrates and under various conditions (oxygen and argon partial pressures, substrate temperature, and pulse-averaged target power density). The resulting films exhibit a broad range of morphologies, from compact solid thin films to wire-like microstructures. We present the optical, electrical, and microstructural properties of the films and suggest their correlations with the discharge parameters as well as the substrate used. We found that the crystalline quality of Ga_2O_3 films and their preferential orientation play a crucial role in achieving improved electrical properties. The optimal crystal structure can be obtained primarily by selecting an appropriate temperature and substrate that promotes the crystalline growth of the film.

MB-ThP-9 Electrochromic Rearview Mirror Utilizing Poly(3,4-Propylenedioxythiophene) Derivative for Advanced Automotive Applications, ***Sindhu Sukumaran Nair [sindhunair@pilani.bits-pilani.ac.in]***, Birla Institute of Technology and Science, Pilani, India

We report the fabrication of single-type electrochromic windows (ECWs) and rearview mirrors (ECMs) using a novel di-4-isopropylbenzyl-substituted propylenedioxythiophene film as the electrochromic active layer. The spectroelectrochemical properties and electrochromic performance of these devices were systematically characterized. The electrochromic devices (ECDs) exhibited a color change between violet in the reduced state and transparent in the oxidized state at redox potentials. Key performance metrics of the ECDs include fast switching times, high coloration efficiency, low switching voltages (±2.0 V), excellent switching stability, and outstanding optical memory retention.

MB-ThP-10 3-Layer Polymer Film Composites Based on PE Recyclates, ***Marcin Bilewicz [marcin.bilewicz@polsl.pl]***, *Tomasz Tanski,* SILESIAN UNIVERSITY OF TECHNOLOGY, Poland*; Tomasz Glinski,* Sinoma, Poland

Keywords: n-layer films; blow molding; polymer composites; recycling; hot-tack

Multilayered films are used recently for many applications like packaging, materials with special barrier properties or with resistance for specific liquids or radiation, e.g. UV. The investigation aimed to obtain the composite in form of 3-layer polymer film and nextly to perform the analysis of the structure and properties of newly developed composite produced using 20 meter high blow moulding technology supported by a precision gravimetric dispensing system. To keep better control, the process was supported by advanced, rotating basket and precise sensors. The film samples were prepared, including a reference film labelled as PE pure and made from standard material, and films with a modified middle layer B, containing regranulate and calcium carbonate in specified proportions. The mechanical strength tests of the sealed films were conducted to verify strength of films in aim to be used for FFS (Form-Fill-Seal) packaging lines and are very promising comparing to single layer films. 3-layer packaging films based on PE recyclates and calcium carbonate in the middle layer, retain their required mechanical properties.

MB-ThP-11 Plasma-Polymer Fluorocarbon Based High Sensitivity Surface Enhanced Raman Spectroscopy Application, ***Sang-Jin Lee [leesj@cbnu.ac.kr]***, Chungbuk National University, Republic of Korea

Surface-enhanced Raman spectroscopy (SERS) provides a powerful analytical tool for molecular identification through the amplification of Raman scattering signals from target analytes on plasmonic nanostructures. In this study, we present a plasma–polymer–fluorocarbon (PPFC)-based nanocomposite thin-film platform designed to achieve high SERS sensitivity

via controlled nanoparticle formation. By tuning the sputtering power density during mid-frequency magnetron sputtering, the distribution and ratio of Ag and Cu nanoparticles embedded in the PPFC matrix were precisely modulated, as confirmed by X-ray photoelectron spectroscopy (XPS) and ultraviolet–visible–near infrared (UV–Vis–NIR) spectroscopy. The optimized Ag–Cu PPFC (CAP) thin films exhibited distinct localized surface plasmon resonance (LSPR) absorption peaks and demonstrated an enhancement factor (EF) of up to 10^8 for rhodamine 6G, supported by finite-difference time-domain (FDTD) simulations showing strong electromagnetic localization at the metal–metal nanogaps. Furthermore, a simplified fabrication approach employing a single composite target of Cu, carbon nanotube (CNT), and PTFE powders (5:60–80:35–15 wt.%) was developed to produce Cu–PPFC nanocomposite films with moderate SERS sensitivity (EF ≈ 2.18×10^4). The prepared CAP and Cu–PPFC nanocomposite films successfully detected rhodamine 6G on flexible polyethylene terephthalate substrates, maintaining distinguishable Raman signals even with reduced optical transmittance. These results demonstrate that plasma–polymer fluorocarbon nanocomposites incorporating Cu and Ag nanoparticles offer a scalable, flexible, and cost-effective route toward high-performance SERS-active substrates suitable for on-site and point-of-care molecular detection applications.

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