New Horizons in Coatings and Thin Films
Room Golden State Ballroom - Session FP-ThP

New Horizons in Coatings and Thin Films (Symposium F) Poster Session

FP-ThP-1 Fabrication of Chemical Bath Deposited ZnO Nanorods Layer Based Ultraviolet Light Detectors and Their Device Properties: Influences of Solution Concentration and Thermal Annealing*, **Tomoaki Terasako**, T. Fujikawa, K. Hirota, K. Kobayashi,* Graduate School of Science and Engineering, Ehime University, Japan*; M. Yagi,* National Institute of Technology, Kagawa College, Japan*; T. Yamamoto,* Materials Design Center, Research Institute, Kochi University of Technology, Japan

Zinc oxide (ZnO) has a bandgap energy of ~3.37 eV which enable to realize ultraviolet (UV) light detectors. In addition, the enhancement of specific surface area by nanosizing the ZnO crystallites is expected to improve the performances of the ZnO based UV light detectors. Among the various techniques for preparing ZnO nanorods (NRs), we have paid attention to chemical bath deposition (CBD) because of its simple procedure, cost-effectiveness and low deposition temperature.

The UV light detectors studied in this paper have a structure of PEDOT:PSS/ZnO NRs/ZnO:Ga(GZO) Schottky junction. To clarify influences of the morphologies and surface states of the NRs on the performance of UV light detecting, the PEDT:PSS/ZnO NRs/GZO Schottky junction UV light detectors with the ZnO NRs layers grown from the CBD solutions with the different concentrations and those annealed under the different conditions are fabricated and characterized.

The GZO seed layers were deposited on alkali-free glass substrates by ion-plating with a DC arc discharge. The ZnO NRs layers were grown by CBD using the mixed aqueous solutions of zinc nitrate hexahydrate (ZnNit) and hexamethylenetetramine (HMT) with the different concentration ratios of HMT to ZnNit ([HMT]/[ZnNit]). The [HMT]/[ZnNit] value was changed in the range of 0.24-3.78. The bath temperature and growth time were ~86°C and 60 min, respectively. Thermal annealing was done to some of the NRs layers in the air. The annealing temperature and time were changed in the ranges of 150-450 °C and 20-60 min, respectively. The PEDOT:PSS layer was spin-coated on the surface of the NRs layer, followed by thermal annealing.

Values of diode ideal factors (n), rectification ratios (I_F/I_R) and potential barrier heights at the PEDOT:PSS/ZnO NRs heterointerfaces (Φ_b) were determined from the voltage-current characteristics taken in a dark. The n values smaller than 2 were obtained in the [HMT]/[ZnNit] range of 0.94-2.83. Both the I_F/I_R and Φ_b increased with increasing [HMT]/[ZnNit]. The UV light detector with the NRs layer grown from the CBD solution with [HMT]/[ZnNit]=0.94 exhibited the maximum ratio of photocurrent (PC) to dark current of 92.6. PC spectra were composed of bands with peaks at ~360 and ~380 nm. The intensity ratio of the 360 nm peak to the 380 nm peak (I_{360nm}/I_{380nm}) showed a maximum at [HMT]/[ZnNit]=0.94. The I_{360nm}/I_{380nm} value decreased along with the change in [HMT]/[ZnNit] from 0.94 towards both the lower and higher sides. The increase in annealing temperature led to the decrease in forward current, resulting in the decrease in I_F/I_R.

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FP-ThP-2 Advances in Nanosynthesis by Atmospheric Pulsed Arc Discharges*, C. Corbella, **Sabine Portal**,* George Washington University, USA*; M. Kundrapu,* Tech-X Corporation, USA*; M. Keidar,* George Washington University, USA

Arc discharges sustained at atmospheric pressure are one type of thermal plasma commonly used in welding, material processing, and more recently, in the synthesis of nanomaterials like graphene, carbon nanotubes, and monolayers of transition metal dichalcogenides. Atmospheric arc plasma fed with periodic power pulses constitutes an excellent way to merge all virtues in one plasma nanosynthesis method, namely competitive deposition rates, lower thermal loads, better utilization of the ablated material, economical use of supplied power, and improved stability of discharges. In contrast with standard glow discharge technologies optimized to obtain nanocomposite materials, anodic arc discharges excited with pulsed power show the unique capability of producing high-purity, stand-alone nanomaterials outside of any supporting host matrices. Here, we review recent efforts to implement pulsed anodic arc discharges for nanosynthesis in four distinct directions: (1) tuning the growth and properties of fullerenes and single- and double-wall carbon nanotubes; (2) localized deposition of nanomaterials on substrates with high spatial resolution; (3) synthesis of heterogeneous nanostructures, especially core-shell nanoparticles, by pulsed plasmas in liquids, and (4) design of pulse waveforms able to generate repetitive and stable arc discharges with minimal production of undesired byproducts, like powder macroparticles. Advanced plasma diagnostics and modeling have been introduced to study the kinetics of nanoparticle growth with spatial-temporal resolution, and the outcome of this research constitutes the forefront of atmospheric arc physics nowadays. Future work requires a deeper understanding of the plasma species transport and its connection with pulse parameters and basic structural information of the grown nanomaterials, such as diameter of nanotubes and thickness of atomic multilayer stacks. A crucial milestone consists of decoding the synthesis-structure-properties sequence involving arc discharges, whose correlations should be developed from a neural network approach. In conclusion, the inherent flexibility of pulsed arc processes by modulating current and voltage waveforms is widely beneficial for the engineering of nanostructured materials with tailored properties attractive for electronic, photonic, and biomedical applications.

FP-ThP-3 Structure, Mechanical Properties, and Thermal Stability of (Gd,Hf,Sc,Ti,Zr)-Nitride Thin Films*, **Alexander Kirnbauer**, M. Derflinger,* TU Wien, Institute of Materials Science and Technology, Austria*; P. Polcik,* Plansee Composite Materials GmbH, Germany*; P. Mayrhofer,* TU Wien, Institute of Materials Science and Technology, Austria

In recent years the exploration of so-called high-entropy alloys (HEAs) and high-entropy metal-sublattice ceramics (HESCs) is in the focus of many research groups. Their unique properties, attributed to the high entropy (> 1.5R) on the metal sublattice, make them interesting for many applications. These materials combine high-hardness and toughness with increased thermal stability as, due to sluggish diffusion, softening processes are slowed down. In a previous study on (Hf,Ta,Ti,V,Zr) nitride we could show that thin films based on the high-entropy concept exhibit outstanding thermal stability as the coatings are single-phased and the elements are randomly distributed up to an annealing temperature of 1300 °C [1]. At higher temperatures the coating decomposes due to nitrogen loss. To overcome the problem of nitrogen loss Ta and V which form a Me_2N solid solution are exchanged by Gd and Sc which do not exhibit a Me_2N phase. For the synthesis of (Gd,Hf,Sc,Ti,Zr) nitride thin films reactive magnetron sputtering was used. We investigated the influence of nitrogen partial pressure as well as substrate temperature on the phase formation and mechanical properties. Therefore, X-ray diffraction and nanoindentation measurements were carried out. The results show that with low nitrogen partial pressure the coatings are partly amorphous while with increasing nitrogen flow the coatings crystallise in a single-phase fcc structure. With increasing substrate temperature, the hardness increases from 23 to 32 GPa. Additionally, to a variation of the deposition parameters, differential scanning calorimetry (DSC) measurements were carried out to investigate the thermal stability and evaluate temperature ranges where phase changes occur. Furthermore, the coating which exhibits the highest hardness was vacuum annealed up to 1200 °C to investigate the change of the mechanical properties upon annealing. The results show that the coatings stay single-phased up to 1000 °C, whereas at higher temperatures phase separation occurs. The hardness thereby decreases from ~32 to 22 GPa.

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FP-ThP-4 Demystifying the Entropy Forming Ability – The Role of Atomic Size Effects*, **Andreas Kretschmer**, P. Mayrhofer,* TU Wien, Institute of Materials Science and Technology, Austria

The desire for rapid materials discovery calls for efficient procedures to explore unknown compositions. This task is especially daunting in the field of high-entropy materials due to the sheer number of possible element combinations to explore. One such procedure has been proposed by Sarker et al. [1], who formulated the so-called entropy forming ability (EFA), using AFLOW-POCC calculations [2], and demonstrated its use on 10 different high-entropy carbides. The tendency to form a single-phase compound was correctly predicted by the magnitude of the EFA.

However, this abstract descriptor lacks a physical explanation, which we have now uncovered by our own simulations. We quantified the lattice distortion in the same carbides as treated in [1], using 10 individual special quasi-random structure (SQS) cells with 64 atoms per carbide, and then calculated the radial distribution function (developed in [3]) of the first coordination sphere. Hereby, we see a strong correlation between the lattice distortion and low EFA values, signifying multi-phase structures. We confirmed this relationship on solid solution carbides with 2, 3, and 4 metals, by calculating both the POCC-derived EFA and the SQS-derived lattice distortion.

Due to the causal relationship of large atomic size mismatch and large lattice distortion we can conclude that the EFA descriptor effectively screens for compositions with low atomic size mismatch, which is already well-known as the Hume-Rothery rules of solid solutions.

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FP-ThP-5 High-Temperature Oxidation Resistance of CrB_2 Coatings Alloyed by Transition Metal Disilicide Phases*, **Ahmed Bahr**, T. Glechner, T. Wojcik, P. Kutrowatz,* Christian Doppler Laboratory for Surface Engineering of high-performance Components, TU Wien, Austria*; J. Ramm, O. Hunold,* Oerlikon Balzers, Oerlikon Surface Solutions AG, Liechtenstein*; S. Kolozsvári, P. Polcik,* Plansee Composite Materials GmbH, Germany*; E. Ntemou, D. Primetzhofer,* Department of Physics and Astronomy, Uppsala University, Sweden*; H. Riedl,* Christian Doppler Laboratory for Surface Engineering of high-performance Components, TU Wien, Austria

Transition metal diborides (TMB_2) are a promising family of materials to be applied as protective coatings in several high-performance applications owing to their high melting point, chemical inertness and outstanding mechanical properties [1]. Among them, CrB_2 exhibits attractive aggregate of properties as good wear resistance, high thermal conductivity and corrosion resistance. However, it suffers rapid oxidation above 600 °C by forming non-protective scales [2].

In this study, we explored the alloying of CrB_2 with secondary TM-silicide phases (TM = Cr, Mo) and investigated the role of the $TMSi_2$ alloying phases on the phase formation, oxidation behavior and mechanical properties of these coatings. We employed direct current magnetron sputtering (DCMS) technique to synthesize alloyed Cr-(TM)-Si-B coatings from compound targets of $CrB_2/MoSi_2$ and $CrB_2/CrSi_2$ providing different compositions. The oxidation kinetics of these coatings have been investigated up to 1400 °C. The alloyedcoatings were analyzed in terms of phase formation and stability, chemical composition, as well as mechanical properties using diverse high-resoultion characterization techniques.

Keywords: CrB_2; Sputtering; Protective Coatings; Oxidation; Phase Stability; Mechanical Properties;

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FP-ThP-6 The Photodetection of the in-, Sn-, and Te-Doped Bi_2Se_3 Nanoplatelets*, **Chih-Chiang Wang**,* National Chin-Yi University of Technology, Taiwan*; H. Shih,* Chinese Culture University, Taiwan*; F. Shieu,* National Chung Hsing University, Taiwan*; A. Lo,* National Chin-Yi University of Technology, Taiwan

The compound Bi_2Se_3 has a narrow band gap of 0.35eV with a rhombohedral crystal structure and is a unique material with the gapless surface-state and the insulating bulk. It is a potential material in the application of photodetection, FET, quantum computation, etc. Bi_2Se_3 has the layered structure composing of 5-atomic layers of Se^1-Bi-Se^2-Bi-Se^1 known as a quintuple layer (QL) with a thickness of around 1 nm. The main bonding type inside the QL is the covalent bonds, and the van der Waals force dominates the bonding between the QLs.

In this investigation, the pure Bi_2Se_3, and In-, Sn-, and Te-doped Bi_2Se_3 nanoplatelets (NPs) were synthesized by the thermal CVD process using horizontal quartz tube at 600℃ under the pressure of 2×10^{-2} Torr, using sapphire as the substrate. The FESEM images show the hexagonal-like morphologies of the NPs. The results of XRD, HRTEM, Raman, and XPS confirm the typical rhombohedral Bi_2Se_3. The photodetection of the pristine Bi_2Se_3NPs shows that the photocurrent and the ratio of photocurrent/dark-current under UV- and under red-light are of the 4×10^{-11} and 23.8×10^{-14}A and 7.7 and 1, respectively, while the co-dopants of In and Sn enhance the photocurrent as well as the ratio of photocurrent/dark-current of the Bi_2Se_3 NPs under UV- and under red-light up to 52×10^{-11} and 3.5×10^{-11}A and 30.7 and 52.2, respectively. The proposed factors can be summarized as the following: (1) formation of the donor defects (In^{3+}_{V0}) and (Sn^{4+}_{Bi3+}), the acceptor defects (V^0_{Bi3+}) and (Sn^{2+}_{Bi3+}), and the neutral defect (In^{3+}_{Bi3+}), (2) the reduced optical band gap of the doped Bi_2Se_3 NPs, and (3) the similar melting point of the powder precursors.

FP-ThP-7 Metallic Zn and Mg Nanowire Coatings by Conventional Reactive DC Sputter Deposition*, J. Zawadzki, **Michał, Adam Borysiewicz**, M. Wzorek,* Łukasiewicz Research Network - Institute of Microelectronics and Photonics, Poland

Metal nanowires owing to their enormous surface-to-volume ratio as well as one-dimensional structure, possess outstanding chemical and physical properties in comparison to bulk materials and are interesting for a broad range of absorbing applications. Magnesium nanowires exhibit a high hydrogen absorption capacity (7.6 wt.%), which determines their potential application in hydrogen storage [1]. Along with zinc nanowires, they are successfully used in energy storage devices such as Mg/air batteries [2] andZn/air batteries [3], respectively. Moreover, zinc nanowires are used as a precursor for obtaining Zn-based semiconductors such as ZnO [4,5], ZnS [5], ZnTe [6], ZnSe [5], which are applied widely in optoelectronics, photonics, and sensing.

Despite of a great effort of scientific groups all over the world, the synthesis of nanowires is still a low-scale process related mostly to solution-based synthesis, or chemical vapor transport processes. The methods of physical vapor deposition (PVD) are an excellent instance of bottom-up techniques not requiring chemical solvents, thereby being eco-friendly and yielding more pure nanostructures. The majority of Zn, Mg nanowire synthesis by PVD methods is based on evaporation techniques [7,8,9,10], while the use of the magnetron sputtering technique [11] remains seldom studied.

On the basis of previous works done by our group on the growth of porous Zn films by reactive magnetron sputtering [12,13], we here demonstrate a catalyst-free method of metallic Zn and Mg nanowire growth using conventional geometries of the reactor chamber (not glancing angle) and cathode. We discuss the synergistic effect of oxygen controlling the morphology of the wires and substrate heating for mass transport for nanowire formation usingbothZn and Mg [see Fig. 1,2]. We discuss the different results for both elements. We comment on the structural and chemical properties of the material and apply high-temperature oxidation to convert them into metal-oxide nanowires. The proposed approach is a big step to achieve a universal method for high-purity, ligand-free metallic nanowires using magnetron sputtering deposition, paving the way for their widespread applications.

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FP-ThP-8 Synthesis and Electrical Properties of Gasb Nanowires*, Tzai-Wei Chen, C. Wang,* National Taiwan University of Science and Technology, Taiwan

In this work, we used anodic aluminum oxide (AAO) template-assisted vacuum die-casting method to prepare GaSb nanowires. Due to their good stoichiometric controllability, low cost and good stability. We can control chemical composition of nanowires easily by modifying composition of bulk. At first, a mixture of gallium ingot (99.99 % purity) and antimony ingot (99.99 %) with an appropriate amount of atomic ratio was entered into quartz tube. Using single zone furnace to heat up to 950 °C and keep for 2 hr then quench into water. GaSb nanowires were synthesized with AAO (annealing at 550 °C for 1hr and non-annealing) template-assisted by vacuum die-casting method. Dissolving time of annealing (400 °C for 24 hr) and non-annealing GaSb nanowires were discussed, respectively. We used different etching solutions (H_2CrO_7 and NaOH solution) to dissolve single and two flakes AAO templates, respectively. The results show that excessive dissolving time and concentration of etching solution cause the nanowires to be damaged or even disappear. The as-fabricated photodetectors via EBL process with 250 nm of Ni as electrode. At 1.0 V bias, the responsivity, EQE and detectivity were calculated to be 7.085×10^3 A/W, 1.352×10^6 % and 6.384×10^{12} Jones, and 2.292×10^3 A/W, 3.42×10^5 % and 1.713×10^{11} Jones under 650 and 780 nm laser illuminated, respectively.

FP-ThP-9 Spacing-controllable core@shell TiO_2@Ru/RuOx Nanotube Array for Biocompatible Stimulating Electrode Applications*, Jia-Jun Li,* National Taipei University of Technology, Taiwan

Recently, implantable bio-electronic devices have attracted considerable attention owing to their promising potential in monitoring and regulating malfunctioned neural systems and internal organs. In operation, these devices require a bio-compatible interface to facilitate the electrical signal communication between inorganic Si-based circuits and neurons/cells in an aqueous environment. A critical parameter for a bio-electrode is its “charge storage capacity” (CSC). A larger CSC is desirable for electrode miniaturization and sufficient neurostimulation.

We develop a chemical bath for a conformal Ru/RuOx deposition with a thickness of ~15 nm on TiO_2 nanotubes with a length of ~800 nm. In addition, we develop an anodization process that can control the spacing of the TiO_2 nanotube array. These Ru/RuOx nanotube arrays undergo electrochemical analysis in charge storage capacity (CSC), charge injection capability (CIC), and electrochemical impedance to evaluate their potential as neurostimulation electrodes for bioelectronics. Images from electron microscopes confirm the formation of uniform Ru/RuOx on both nanotubes' internal and external surfaces. An X-ray diffraction pattern indicates a good crystallinity of the Ru/RuOx nanotube array. In addition, the cycling lifetime of Ru/RuOx nanotube arrays is evaluated by performing CV scans for 1,000 cycles with a scan rate of 0.1 V/s. The Ru/RuOx nanotube arrays reveal large CSC values and low electrochemical impedances, which are attributed to hollow tubular nanostructure with Ru/RuOx deposition.Additionally, the Ru/RuOx-coated TiO_2 nanotube array exhibits stability, durability, and good biocompatibility.

FP-ThP-10 Nickel Sulfide on Organic Framework for Efficient Hydrogen Evolution Reaction*, Yu-An Chi,* Department of Materials and Optoelectronic Science, National Sun Yat-Sen University, Taiwan*; T. Chang, C. Kung,* Department of Chemical Engineering, National Cheng Kung University, Taiwan*; C. Chen,* Department of Materials and Optoelectronic Science, National Sun Yat-Sen University, Taiwan

Hydrogen is eco-friendly and high-efficient energy. Choosing the electrocatalysts for hydrogen evolution reaction (HER) is an essential challenge to water splitting. And then transition metal chalcogenides (TMCs) are easy to prepare and cheap, so this works chemical vapor deposition (CVD) to sulfurize nickel-based metal-organic framework (MOF). The Scanning Electron Microscope (SEM) results of α-NiS-MOF indicate that the extensions on the branch can increase surface area. Experimentally, the electrochemical measurement results reveal that MOF after sulfidation has enhanced HER electrocatalytic performance in 1 M KOH (overpotential is 76.7 mV and 210 mV at the current density of -10 mA/cm^2 and -100 mA/cm^2), and widely improve electrochemical surface area (electrical double-layer capacitance is 0.8336 F/cm^2) compared to nickel foam after sulfidation. At the same time, X-ray photoelectron spectroscopy (XPS) was used to observe the chemical state changes of the surface elements of the electrocatalyst before and after the hydrogen evolution reaction. As a result, this work demonstrates a facile synthesis to optimize nickel sulfide electrocatalysts to improve their electrocatalytic performance for practical applications in future energy devices.

FP-ThP-11 Research of The Growth Mechanism of Solvothermally Synthesized Sb_2Te_3 Nanosheets*, Yen-Jen Lin,* *C. Chen,* Department of Materials and Optoelectronic Science, National Sun Yat-Sen University, Taiwan

Sb_2Te_3 is one of the topological insulated (TI) materials. Owing to the strong electron spin-orbital coupling, TI materials have conductive surfaces, and the inside parts are insulated. One of the most critical factors in showing the topological insulating property is the thickness of the materials. In this work, we successfully synthesized Sb_2Te_3 nanosheets by solvothermal method. Inspecting the growth process using scanning electron microscopy showed that we obtained Te nanowire initially. Te nanowire then turned into Sb_2Te_3-Te hierarchical nanostructure with increasing of time and finally into Sb_2Te_3 nanosheets. We can suggest the growth mechanism of Sb_2Te_3 nanosheets from the results. We also found that the absorption range in UV-Vis was different by the difference of experimental products. It has become a convenient method to identify the section of the as-prepared products. Furthermore, we also found that by tuning the concentration of NaOH or increasing temperature, we can successfully synthesize nanosheets with a radius and thickness of 1.5 µm and 9.8 nm, respectively. Being able to well-control the thickness of Sb_2Te_3 nanosheets is very helpful for the subsequent component fabrication.

FP-ThP-12 Exploring Zn-Sn-O (ZTO) Composition Spreads with Combinatorial Sputtering*, Siang-Yun Li,* *Y. Shen, K. Chang, W. Wu, J. Ting,* National Cheng Kung University, Taiwan

Transparent conducting oxide (TCO) films are extensively applied as electrodes in the fields of solar cells and displays, due to their high transparency and excellent conductivity. Multicomponent oxides such as Zn-Sn-O (ZTO) have attracted much attention resulting from no expensive elements, i.e. indium (In), involved. In addition, thermal stability and mechanical strength of ZTO could be tailored as well by varying its stoichiometry. However, making different ratios of Zn/Sn compounds systematically is not trivial.

Combinatorial methodology has been proven its validity in such an application. This approach allows Zn/Sn continuously changing across the single sample area and a feasible intimate mix of Zn and Sn. Therefore, a single ZTO composition spread sample essentially includes a full spectrum of properties to be investigated. A Zn-Sn-O (ZTO) composition spread, consisting of thickness wedges of SnO and ZnO, was prepared using a state-of-the-art combinatorial sputtering system, equipped with a moving shutter and two RF guns for the targets of Zn and Sn, respectively. The thickness gradient was determined using SEM, α-step and SIMS. It was found a smooth thickness variation across the sample area for both ZnO and SnO with the coefficient of determination (R2) ≅ 0.99, indicating a good control of the ZTO composition spread. Structure evolution was characterized using XRD. We found in-situ 500 ºC annealing resulted in crystallization of the samples, where ZnO, Zn2SnO4, ZnSnO3, and SnO2 phases were observed, depending upon the ZnO/SnO ratios on the ZTO composition spread. The resistivity was characterized using a four-point probe on different substrates, which revealed lower resistivity near ZnO-rich. Morphology and optical characteristics were studied as well using AFM, SEM and UV-Vis spectrometry. A clear variation trend of both properties was observed. A systematic study of physical properties of ZTO has been successfully demonstrated.

FP-ThP-14 High-Precision Feedback Control Measurements of the Aluminum-Oxygen Double Hysteresis Curve in Reactive Magnetron Sputtering*, Josja Van Bever,* *K. Strijckmans, D. Depla,* Ghent University, Belgium

Feedback process control [1] of reactive sputtering can be used to achieve specific thin film properties. Although conceptually simple, it is far from trivial to make it reliable and reproducible.

Depending on the initial state of the process two S-shaped process curves can be obtained under certain conditions [1]. It is shown in our most recent work [2-4] that this phenomenon, which is termed *double hysteresis*, is related to implanted oxygen ions that are eroded from the target surface before having reacted with the target metal. While the two S-shaped curves can be clearly observed using *IV-characteristics* [5], no accurate measurements of the states with *feedback control* have been obtained yet.

Feedback measurements of double hysteresis curves are however of great use. First, such measurements deliver a *direct proof* of the phenomenon. When using IV-characteristics, a much broader data set must be obtained [5]. Therefore, the double hysteresis curves cannot be obtained as a function of erosion time or process parameters that are known to influence double hysteresis [2-4]. *With feedback control, the complete double hysteresis curve can be characterized with one target and within a limited amount of erosion.* Finally, good control of discharge voltage and/or oxygen pressure is required to investigate properties of films deposited within the meta-stable region. This is only feasible with feedback control.

In this poster we present high-precision feedback measurements of double hysteresis curves of the aluminum-oxygen system. We address problems encountered during such measurements, ranging from controlling instabilities and relaxation of the sputtering system to accurately switching between different types of feedback. The sampling of totally new target states is discussed. *A new measurement protocol is introduced and implemented in the software package "RSDmeasure"*. We use the developed protocol to obtain the first direct proof of double hysteresis during reactive magnetron sputtering and the *first complete characterization of double hysteresis curves as a function of process parameters* that are of interest to manipulate the reactive sputtering process.

Additional figures and references are found in the supplementary material.

FP-ThP-16 Synthesis and Characterization of Titanium Thin Films by Magnetron Sputtering and the Effect of the Addition of a Graphite Anode*,*

D. Jacobo Mora, M. Martinez Fuentes, ***Stephen Muhl,*** Universidad Nacional Autónoma de México

Titanium (Ti) thin films were deposited onto glass substrates using two different setups: normal DC magnetron sputtering [MS] and by MS assisted by a secondary graphite anode discharge. The films were analysed as a function of the argon gas pressure, the MS power and voltage applied to the anode. The properties of the films, film thickness, adhesion and hardness were studied as a function of the experimental paraments used for the deposition. Lastly, optical emission spectroscopy (OES) was used analyse the two types of discharge.

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Keywords: Magnetron sputtering; Optical emission spectroscopy; Deposition rate; Adhesion.

FP-ThP-17 Developing Materials for Future Generation Nuclear Reactors*,*

Vladimir Vishnyakov, Huddersfield University, UK

Nuclear reactors have a very extended list of material requirements. Long-term environmental concerns related to decommissioning add to the list of requirements and limit the score of chemical elements which can be utilised. Stringent safety obligations necessitate treating almost any modification of material properties in service as damage. Self-healing in broad sense materials need to be well understood and crafted to enable safe future nuclear reactor operation. The self-healing relies on repair mechanisms when the material preserves its properties under severe conditions and radiation damage. Atomic level processes such as point defect recombination, defect diffusion, defect sinks and process activation energies need to be well understood. Self-healing processes in materials for nuclear energy generation will be examined on the developed solutions in thin film High Entropy Alloys, High Entropy Ceramics and MAX phases. Empirical suggestions for future development of nuclear reactor alloys will be discussed.

FP-ThP-19 Effect of Surface Treatment on the Bifunctional Performance of Core-Shelled High Entropy Spinel Oxides*,*

Yi- Ting Jhuo, National Cheng Kung University (NCKU), Taiwan*; T. Nguyen,* National Cheng Kung University (NCKU), Taiwan, Viet Nam*; J. Ting,* National Cheng Kung University (NCKU), Taiwan

Several high entropy spinel oxides were prepared using microwave hydrothermal method and used as electrocatalysts for oxygen evolution reaction (OER) and oxygen reduction reaction (ORR). The surface plasma treatment was conducted under different powers, times, gases, and pressures. The resulting samples were first characterized using X-ray diffractometer, scanning electron microscope, transmission electron microscope, energy dispersive spectrometer, X-ray photoelectron spectroscopy. Electrochemical performance was evaluated using electrochemical impedance spectroscopy, linear sweep voltammetry, cyclic voltammetry. The effect of surface treatment using plasma on the bifunctional OER/ORR performance is addressed.

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