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Surface Engineering - Applied Research and Industrial Applications
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Surface Engineering - Applied Research and Industrial Applications (Symposium G) Poster Session

GP-1 Corrosion Induced Diffusion Pathways in Thin Film Materials Investigated by Atom Probe Tomography, ***Oliver Hudak (oliver.hudak@tuwien.ac.at)***, CDL-SEC, TU Wien, Austria*; E. Aschauer,* TU Wien, CDL-SEC, Austria*; V. Dalbauer,* FAU Erlangen, Germany*; L. Shang, O. Hunold, M. Arndt,* Oerlikon Balzers, Oerlikon Surface Solutions AG, Liechtenstein*; P. Polcik,* Plansee Composite Materials GmbH, Germany*; P. Felfer,* FAU Erlangen, Germany*; H. Riedl,* TU Wien, CDL-SEC, Austria

Corrosion processes are common phenomena in fields of engineering and there is nearly never an instance, where a material is totally inert to its environment and its corrosive nature. Therefore, corrosion and corrosion-resistance are essential variables that play a pivotal role in the development of protective coatings. Ingenuity of next generation PVD coatings has given rise to a wide range of material concepts set out to withstand all kinds of corrosive attacks (e.g. NaCl, HCl, SO_3 and O_2). While their performance is mostly assessed on descriptors such as mass change, impairment of mechanical properties, or variance in electrochemical surface potential, little work has been dedicated to understand corrosion driven diffusion pathways, specifically on an atomic scale.

This study showcases a systematic approach on highlighting preferred diffusion pathways of corrosive media in arc-PVD thin films. For investigating the effect of grain size, droplet formation and crystallinity on the overall diffusion mechanism, a novel marker architecture was developed. Eliciting chemical and structural changes upon arrival of the diffused media, this marker system facilitates improved application of high-resolution analytical methods, such as APT and TEM, to help identify preferential diffusion paths.

GP-2 Engineered Phase Differences between HiPIMS Power and Substrate Bias for Improved Mechanical Properties of Titanium Nitrides, ***Ying-Xiang Lin (qw36100@gmail.com)***, *W. Wu,* Da-Yeh University, Taiwan

In order to enhance the hardness, density, and adhesion of the deposited film, a substrate bias was normally applied during the deposition to attract ions to the substrate to increase the bombardment of the Ar^+ on the film. However, an excessively ion bombardment also causes an extremely high compressive residual stress of the film and leads to peel off. Therefore, adjusting the substrate bias voltage to obtain a proper ion impact to the film is an important factor in the process. High-power pulsed magnetron sputtering (HiPIMS) is an advanced technology of conventional magnetron sputtering. The plasma density of HiPIMS is three levels higher than conventional magnetron sputtering due to its high ionization rate. Therefore, a high amount charged particles are generated in the HiPIMS process. Applying a DC bias voltage in HiPIMS process helps these charged particles reach the substrate, but a high amount charged particles also cause the bias fail instantaneously. Meanwhile, two group high-energy ions of gas and target were observed when the pulse is turned on and off, respectively. Therefore, adjusting the phase differences between HiPIMS power and substrate bias becomes critical in a HiPIMS deposition process. However, the effect of applying synchronized and phase different bias on the film deposition has not been detail discussed.

Ti films have high mechanical strength and excellent corrosion resistance and are often used as an interface layer for TiN deposition to enhance adhesion. In this study, different phase difference bias of HiPIMS deposited Ti and TiN layer was individually investigated. A DC substrate bias was also used for comparison. The plasma composition in front of the target and substrate was individually analyzed by optical emission spectroscopy (OES), and it was found that Ti^{2+} and Ar^+ increased significantly at the substrate after applying DC bias and pulsed bias. According to the XRD, SEM and AFM results, the grain size and surface roughness of Ti and TiN decreased when a DC bias was applied. The enhanced (002) plane was observed when a synchronous pulse bias was applied. Finally, the corrosion resistance of Ti/TiN was analyzed to determine the best substrate bias condition for HiPIMS process.

Keywords: HiPIMS, TiN/Ti, Phase difference pulse bias, Substrate bias

GP-3 Thermally Spayed Coatings with Integrated Sensor Systems for Tribological Load Surfaces, ***Annett Dorner-Reisel (a.dorner-reisel@hs-sm.de)***, Schmalkalden University of Applied Sciences, Germany*; W. Ahmad Akhtar, J. Seeger, G. Reisel,* Oerlikon Metco WOKA GmbH Barchfeld, Germany

Monitoring systems for load, damage, temperature, fatigue assessment during operating of machines, wind turbines or transportation systems are of great interest. The main focus of the present research is the development of a strain and stress sensing reliable sensor, that signals overloading and general behaviour and its protection during operating, what would give a long durability of the smart property. In addition to the sensors sensitivity against stress and strains, it needs to be adequate protected. Therefore, films and coatings are selected and proven.

These thin films and coatings were deposited on piezo-sensor systems. The aims are:

(a) protection of the piezo-sensor during embedding process

(b) protection of the sensor during tribological loading during practical application of the metallic components

(c) receiving proper electric signals from embedded sensors

Thermally sprayed WC-NiCr and Cr3C2-NiCr coatings with approximately 250 µm thickness were deposited on steel substrates. Flat piezoelectric sensors were embedded. Tribological behaviour of thermally sprayed coatings without and with sensor embedding was tested. The Palmqvist fracture toughness was measured and data are correlated to the wear behaviour and the electric signals from the coatings.

GP-4 Performance Enhancement of pGe MOS device with Pre- and Post-Deposition Microwave Annealing Treatment, ***Yu-Hsuan Chien (teresa.chien888@gmail.com)***, National Tsing Hua University, Taiwan*; K. Chang-Liao, D. Ruan, S. Yi,* National Tsing Hua University, Taiwan*; F. Chu,* National Tsing Hua University, Taiwan

Recently, germanium (Ge) based metal-oxide-semiconductor (MOS) device with high-k gate insulator has been widely investigated for its higher electron and hole mobility than silicon, and easier integration with traditional technology than III–V materials. Beside, microwave annealing process was proposed to improve electrical characteristics for its lower thermal budget compared with the traditional annealing process. In this work, complete microwave annealing treatments have been applied on the pGe MOS device, instead of the traditional thermal process. As a result, the device with both pre- and post- deposition microwave annealing exhibits better electrical performance than other samples.

GP-5 Design of Surface Layers with Phase Change with Novel Properties, ***Rahul Basu (ra4499@gmail.com)***, VTU Kundana, Bangalore, India

A model for a phase change layer with thermal and mass transport is formulated/ Variable diffusivity and surface conditions are embedded in the model. Subsequently boundary lengths for mass and thermal penetration are evaluated by special techniques. Diffusivities which ares normally assumed constant, are allowed to vary as transformations progress. Solutions for specific variable diffusivities are computed where penetration lengths are evaluated. An integral method is applied along with perturbation expansions,to evaluate the boundary layer thickness. Applications are postulated for self healing paints, roofing material, radar absorbing/deflecting coatings and other possible consumer and military spinoffs.

GP-6 Effect of Cu Content and Melting Temperature on the Oxide Film Formation and the Quality of Molten 6000-Series Aluminum Alloys, *H. Jang, P. Youn, H. Kang, G. Lee, J. Park, E. Kim, J. Jeon,* ***Sunmi Shin (smshin@kitech.re.kr)***, Korea Institute of Industrial Technology (KITECH), Republic of Korea

In recent years, the interest of high strength aluminum alloys is growing due to the demand for the light-weight vehicles to meet the strengthened environmental regulations. Heat treatable 6000-series aluminum alloys (Al-Mg-Si alloys) are the typical high-strength aluminum alloys and are widely used as a panel material because of its thermosetting property, which increases the strength when baked finish. The inclusions formed during casting can affect the precipitate formation in the post heat treatment process and impede the work hardening ability of nano-precipitates of Al-Mg-Si alloys. The inclusion formation during casting is affected by the alloying elements, the liquid state oxidation of the alloy surface, and the casting process conditions. In order to reduce the internal defects and

improve the mechanical properties of high-Cu-containing Al-Mg-Si alloys, the effect of Cu content on the oxide film formation on the surface of the molten alloys need to be clarified and the quality of molten alloys should be precisely controlled. In this study, the oxide film on the surface of molten Al-Mg-Si-Cu alloys was characterized by electron microscopy and DSC-TGA and the effect of Cu content and the melting temperature on the oxide film formation energy was estimated by thermodynamic calculations. In relation to the characteristics of the oxide film, the melt quality of Al-Mg-Si-Cu alloys was discussed.

GP-7 TiO_2–Silicon Nanowire Arrays for Inorganic Solar Cell Applications, ***Ai-Huei Chiou (ahchiou@nfu.edu.tw)***,** National Formosa University, Taiwan

Large-area ordered single crystal SiNW arrays on p-type (100) silicon wafer without the use of a template were prepared in a silver nitrate and hydrofluoric acid ($HF/AgNO_3$) solution at 50oC. The result showed that highly dominant peak at 69° is belong to (004) silicon plane which can be explained equally by preferential etching along [100] directions. The linear relationship of SiNW arrays could be adjusted by controlling the etching time. Besides, the result showed that SiNWs gave the best anti reflective properties (3.07% in the broad visible band) and well-aligned properties with 45 minutes. A n-TiO_2/p-SiNW heterojunction has been fabricated by RF magnetron sputter. The crystal structure of TiO_2 layer reveal its anatase and rutile both structured hybrid. A n-type TiO_2 thin films were deposited sputtering on the p-SiNW arrays having hydrophilicity features. In this study, a rare inorganic-inorganic heterojunction solar cells using titanium dioxide and silicon nanowires was fabricated. The present results indicated that the power conversion efficiency (PCE) of n- TiO_2/p-SiNWs better than n- TiO_2/p-Si inorganic-inorganic heterojunction solar cells. The inorganic-inorganic heterojunction solar cells used itanium dioxide and silicon nanowires, in which the Voc is of 0.139V, Jsc is of 94.81 mA/cm2 and, the FF is of 21.3% and efficiency is of $2.81 \times 10^{-3\%}$. Key words: silicon nanowires (SiNWs), Electroless Metal Deposition (EMD), inorganic solar cell

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