Surface Engineering - Applied Research and Industrial Applications
Room Golden State Ballroom - Session IA-ThP

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

IA-ThP-1 Application and Practice of Surface Aluminization Treatment in Zinc Pot Equipment of Hot Dip Galvanizing Production Line, ***Lu Wang (4986208@qq.com)***, BAOSTEEL, China

hot dip galvanizing is a process of coating the surface of a steel strip with a zinc layer to prevent corrosion. This process is widely used in industries such as automobiles, home appliances, and construction. During the hot dip galvanizing process, various components on the galvanizing line are immersed in the high-temperature molten zinc liquid in the zinc pot, which has a certain degree of corrosiveness and can cause corrosion to components such as sink rolls, stabilizing rolls, zinc pumps, and snout. In the continuous hot dip galvanizing process of strip steel, due to the corrosiveness of the high-temperature molten zinc liquid in the zinc pot, the service life of some components in the galvanizing equipment is concise, with an average service life of only 12-15 days. This seriously restricts the production efficiency of continuous hot dip galvanizing, increases economic costs, and also affects product quality. Parts in direct contact with high-temperature molten zinc on the galvanizing line are required to resist zinc corrosion and thermal shock.

The use of thermal spraying technology for surface coating treatment of components in zinc pots can have a certain anti-corrosion effect, but it cannot be widely used due to its high cost. This article introduces an aluminizing technology that involves placing components in a molten aluminum pot for hot dip aluminum pot, and then diffusing at a temperature of 800-950 ℃ to transform all the aluminum plating layers on the hot-dip aluminum surface into aluminum iron compound layers, forming a diffusion type aluminizing layer. This thin film can effectively prevent the corrosion of zinc solution on components and also inhibit the formation of zinc dross on the surface of components.

Through experiments, we found that after muffle furnace annealing, a uniform and dense Al2O3 film is formed on the surface of aluminized stainless steel. Aluminum oxide has unique properties that metal and organic polymer materials do not have. Aluminum oxide films have excellent wear resistance, corrosion resistance, heat resistance, high-temperature oxidation resistance, insulation, and other properties. The Al2O3 film isolates the steel substrate from the zinc liquid, preventing mutual diffusion and reaction between Fe and Zn atoms. The Al2O3 film serves as an isolation layer, which can prevent corrosion of the steel substrate by zinc liquid. The cost of this surface aluminizing treatment is much lower than that of thermal spraying, which not only prolongs the service life of the components but also significantly reduces maintenance costs.

IA-ThP-5 e-Poster Presentation: Bismuth Thin Film Electrodes, *B. Frontana-Uribe, V. Ugalde-Saldivar, A. Hernandez-Gordillo, A. Vazquez,* Universidad Nacional Autónoma de Mexico*;* ***Sandra E. Rodil (srodil@unam.mx)***, Universidad Nacional Autonoma de Mexico

Bismuth film electrodes (BiFE) for trace metal detection using electroanalytical techniques have been researched since 2000, after the demonstration that the BiFE could substitute mercury drop or mercury film electrodes, leading to a safer and eco-friendly solution. However, after more than 20 years of research, the BiFEs are not yet available for commercial use. In this work, bismuth-based thin films produced by magnetron sputtering have been tested for detecting trace metals and organic molecules of interest. Moreover, the stability of the Bismuth-based electrodes in different non-aqueous solutions has been studied, aiming to use the electrodes for the electrosynthesis of organic molecules.

Pure bismuth, bismuth-tin, and bismuth-indium films were deposited on both smooth and rough glass substrates. These were used as the working electrodes in a three-electrode electrochemical cell, where different electroanalytical techniques were used to detect metal ions or organic molecules of interest, such as acetaldehyde. The same electrodes were also tested for the electrosynthesis of organic molecules, which constitutes a sustainable method to produce high-value chemicals without using catalysts.

The results are summarized to present the potential use of bismuth-based electrodes produced by a physical vapor deposition technique for detecting cadmium, zinc, acetaldehyde, and insulin. The Bi-In electrode was tested to drive the cathodic reduction of benzophenone using Cyrene™/EtOH (1 : 1) as a green solvent mixture. Interestingly, the Bi–In electrode yielded a 56% of the pinacolic compound. Such reaction can be used to prepare alcohols and diols from the electrochemical reduction of carbonyl compounds, such as aldehydes and ketones.

IA-ThP-6 Fabrication of TiO_2 Nanotube/SiNW Arrays Structure at Different Synthesis Parameters for Solar Cell Application, ***Ai-Huei Chiou (ahchiou@gs.nfu.edu.tw)***, *Z. Lin,* National Formosa University, Taiwan

Titanium dioxide is renowned for its non-toxicity, high chemical stability, and excellent photocatalytic activity, making it widely applicable in areas such as photocatalysis, photodegradation, and solar energy-related applications. Various methods, including hydrothermal synthesis, sol-gel techniques, and anodization, can be employed to obtain titanium dioxide nanostructures. Among these methods, anodization is favored by many researchers for its simplicity, cost-effectiveness, and ease of observation.

This study utilizes the anodization method to prepare a novel hybrid silicon nanowire array structure and explores its feasibility for application in solar cells. The research primarily focuses on the preparation of titanium dioxide nanotube structures, comparing the results of nanoscale structures with non-nanoscale structures in solar energy measurements.

Currently, most anodization methods used for preparing titanium dioxide nanotubes utilize platinum metal as the cathode, despite its better stability, it is expensive. The anode is typically made of pure titanium foil or sheet. In this study, a novel structure is proposed, involving the deposition of a seed layer on the anode silicon nanowire array, and using a pure titanium plate as the cathode for anodization. The study investigates structural changes under different experimental parameters.

The research employs a trial-and-error approach to sequentially adjust parameters such as electrolyte water content, current, voltage, and film thickness to confirm the conditions for subsequent anodization. A magnetron sputtering machine is used to deposit titanium on the silicon nanowire array, and finally, anodization is employed to prepare a divergent structure of titanium dioxide nanotubes.

SEM observations indicate that with appropriate water content, current, voltage, and film thickness, a complete pore morphology can be obtained. Raman analysis reveals TiO2 lattice peaks under different growth times, confirming the prepared TiO2 has a rutile structure. Additionally, UV-Vis analysis shows that when the substrate is non-nanoscale, the reflectance is approximately 80%, but when the substrate is a silicon nanowire, the reflectance decreases with increasing TiO2 thickness. In terms of electrical properties and solar energy analysis, the TiO2 nanotube/Si structure demonstrates a conductivity of 8.856×10^{-7} S/cm and a photovoltaic conversion efficiency of 2.31×10^{-3}, while the TiO_2 nanotube/SiNW Arrays Structure exhibits a similar conductivity of 8.856×1010^{-7} S/cm and a higher photovoltaic conversion efficiency of 5.46×10^{-3}.

IA-ThP-7 Process-Awared Compact Modeling to Obtain Consistent Performance for Various Gate-All-Around Structures Due to Vertical Oxidation and Etching Process of 3D Charge Trapping Flash Memory, ***Sunghwan Cho (joboss9999@gmail.com)***, Samsung Electronics and Department of Semiconductor and Display Engineering, Sungkyunkwan University, Republic of Korea

To address the scaling limitations of conventional planar flash memory, gate-all-around (GAA) charge trapping flash (CTF) memory has emerged as the most promising alternative, offering significantly larger storage capacity and reduced disturbance. However, as more layers are stacked vertically and feature sizes are decreased, it becomes increasingly challenging to manage vertical processes like etching or oxidation, leading to variations in geometry such as hole radius or tunneling oxide thickness, respectively. Furthermore, unexpected process variations along the word lines (WLs) pose challenges for circuit designers in optimizing conditions for consistent performance, primarily due to the absence of a framework based on circuit simulation. Therefore, in this study, we introduce a compact modeling approach aimed at delivering optimized solutions for achieving uniform performance after program and erase operations along the WLs, thereby reducing the effects of process variations inherent in vertical GAA structures within 3D CTF memory devices such as hole etching and vertical oxidation. The program and erase performance exhibit unexpected differences due to variations in the etching process and vertical oxidation within gate-all-around structures, resulting in variations in hole radius and tunneling oxide thickness along the WLs, as shown in Fig. 1 and 2. We presented diverse variations in hole radius and tunneling oxide thickness across three representative GAA structures (trapezoid, entasis and iterated trapezoid in Fig. 1). Then, utilizing the proposed workflow outlined in this paper, we extracted optimized WL gate biases to ensure a uniform electric field along the WLs, as shown in Fig. 3. Finally, we presented the variation in program speed across different locations within a string and demonstrated consequent uniform performance using SPICE simulation, as shown in Fig. 4. As a valuable framework, the proposed compact modeling enables circuit designers to optimize design schemes for consistent behavior in 3D CTF memory devices.

IA-ThP-8 Disruption of Cell Wall Using Non-Thermal Plasma for Recovery of Intracellular Lipid to Be Used as Bio Lubricant*, JOSÉ GERALDO PRADELLA (jpradella51@gmail.com),* Universidade do Vale do Paraiba, Brazil

Rhodosporidium toruloides stands out as a highly promising oleaginous yeast, renowned for its capacity to amass substantial quantities of intracellular neutral lipids. These lipid reservoirs hold significant commercial value across diverse industries such as biofuels, food production, chemicals, pharmaceuticals, and bio lubricants. Leveraging non-thermal plasma for yeast cell wall disruption presents a distinct advantage in preserving the integrity of these sought-after intracellular components. The cultivation process of this oleaginous yeast involves two distinct stages, each utilizing specific culture media. The inoculum phase employs Saboraud medium, while the production phase utilizes a defined medium with a C/N optimized ratio. Following the fermentation stage, the harvested material undergoes centrifugation, with the discarded supernatant paving the way for subsequent non-thermal plasma treatment. This plasma process, executed in triplicate with five samples, incorporates variations in exposure time—ranging from 5 to 30 minutes—while keeping other parameters constant. Characterization of the samples, both before and after plasma treatment, involves comprehensive analysis using scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), and tribometer assessments. Notably, tribometer evaluations employ the treated samples as a biolubricant interface between a 316L plaque and sphere. The results display a progressive disruption of the yeast cell wall upon exposure to non-thermal plasma, with noticeable effects emerging as early as 5 minutes and culminating in complete destruction within the 30-minute timeframe. The FTIR was used to analyses the bio lubricant structure before and after friction tests. This study underscores the immense potential of non-thermal plasma as a groundbreaking technique for efficiently extracting lipids through cell wall disruption, thereby contributing to the advancement of sustainable bioprocessing and bio lubricant production.

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