Thursday Morning, April 29, 2021

Live Session

Room Live - Session LI-ThM2

Thin Films for Energy Applications Live Session

Moderators: Dr. Peter Kelly, Manchester Metropolitan University, UK, Dr. Glen West, Manchester Metropolitan University, UK

11:00am **LI-ThM2-1 Welcome and Thank You to our Sponsors!**, ***Peter Kelly (peter.kelly@mmu.ac.uk)***, Manchester Metropolitan University, UK

Welcome to the ICMCTF 2021 Virtual Conference! We hope you will enjoy the invited talks!

11:15am **LI-ThM2-2 Advanced Nanomaterials for Energy-Related Applications**, ***Eva Schubert (evaschub@engr.unl.edu)***, *C. Briley, U. Kilic, M. Hilfiker,* University of Nebraska-Lincoln, USA*; D. Sekora,* Honeywell Inc.*; M. Schubert,* University of Nebraska-Lincoln, USA **INVITED**

Advancements in nanomaterial fabrication impact and revolutionize pathways to control properties and functionality of devices by using building-block approaches to tailor the material structure during synthesis. With more precision during fabrication processes modern nanotechnology opens up new venues for energy-efficient, low power-consumption and environmentally resourceful applications in diverse industries. Oblique angle deposition is a sophisticated method for bottom-up fabrication of single and multilayer slanted columnar and chiral nanomaterials. The arrangement of nanostructures across a substrate form highly porous thin films with enhanced surface area and large void fractions, which allow interactions with gaseous, liquid or other solid materials in hybrid systems.

We report on utilizing oblique angle deposition to tweak material properties on the nanoscale by arranging building blocks of transition metals (Ti, Co, Pt, Cr etc.), permalloy or silicon to form single and multilayer nanowires and nanospirals. The shape of the nanostructures is determined by anisotropic atomic shadowing and control of surface diffusion during material growth utilizing an oblique angle of incidence for the particle flux. Based on chemical composition and shape of the nanomaterials we discuss unique biaxial anisotropy in their magnetic, photonic and optical behaviors in the context of energy related applications. Special emphasis will be given to applications for energy storage on the example of Li-ion based batteries using large surface nanowire electrodes from silicon and ferromagnetic Co/Py heterostructure nanowires which exhibit high magnetic energy products.

Reversable Li-ion intercalation is achieved by cyclic voltammetry from electrochemical half-cells. During intercalation the electrode material experiences dramatic structural changes which are studied in-situ by means of spectroscopic ellipsometry. The reversible change of the chemical composition and volume expansion are thereby monitored by a change in the optical response and quantified in the context of the inserted and extracted amounts of Li-ions.

Ferromagnetic multilayer nanowires are grown with one or two periods of Co/Py and coated by thin alumina barriers to prevent oxidation. An octupol vector magnet spectroscopic ellipsometry system is used to measure the anisotropic magneto-optical response, and magnetic hysteresis is extracted from line-shape regression optical models accounting for the magnetic order in the materials. We demonstrate that periodicity of the multilayers can be used to optimize the stored magnetic energy given by the energy product from flux density B and field strength H.

11:45am **LI-ThM2-4 Photocatalytic Bismuth Oxide Coatings and their Potential for Water Treatment Applications**, ***Marina Ratova (m.ratova@mmu.ac.uk)***, *J. Redfern,* Manchester Metropolitan University, UK*; C. Amorim,* Universidade Federal de Minas Gerais, Brazil*; P. Kelly,* Manchester Metropolitan University, UK **INVITED**

As the levels of industrialization and urbanization in the modern world increases, so will the amount of waste, with increasing potential to contaminate water, air and soil. Consequently, there is an urgent requirement for reliable and efficient methods to treat persistent organic pollutants as well as microbial contamination. Bismuth-based oxides, and in particular bismuth oxide and bismuth tungstate, have recently attracted attention as promising photocatalytic materials for water treatment processes. In the present work, novel photocatalytic narrow band gap semiconducting films were prepared by pulsed direct current (DC) reactive magnetron sputtering of Bi (and W) targets in an Ar/O2 atmosphere onto spherically-shaped glass beads. The uniform coverage of the substrate was enabled by the use of oscillating bowl placed underneath the magnetrons. The deposited films were extensively analysed by the range of analytical techniques. The photocatalytic properties of the films were studied via the various dyes degradation process under artificial (fluorescent light) and natural (sunlight) irradiation, and compared to the photocatalytic performance of conventional photocatalytic material, titanium dioxide, deposited onto identical substrates. However, for efficient water treatment processes, disinfection is as important as decontamination. Therefore, antimicrobial efficiency of the coatings was tested via inactivation of E. coli; additionally, bacterial adhesion experiments were performed for all types of the studied coatings. It was found that the performance of bismuth oxide for both dye degradation and bacterial inactivation experiments under visible light was superior to that observed for either bismuth tungstate or titanium dioxide. Moreover, bismuth oxide coatings (and to a lesser extent – bismuth tungstate), due to its hydrophobic nature was able to inhibit bacterial adhesion to the surface. The latter phenomenon is likely to afford bismuth oxide coatings additional antifouling properties compared to conventional titanium dioxide-based photocatalytic coatings. These findings, along with the follow-up studies on bismuth oxide antimicrobial efficiency against common water-borne pathogens and other microbiology-related factors including the effect of bismuth oxide photocatalysis on the presence of genomic DNA, bacteriophage and human hepatotoxicity of treated water, are likely to be of interest to those involved in visible or solar light-irradiated water treatment systems, where effective disinfection of the treated media is as important as degradation of the pollutants.

12:15pm **LI-ThM2-6 High Entropy Materials for Energy Applications**, ***Jyh-Ming Ting (jting@mail.ncku.edu.tw)***, National Cheng Kung University, Taiwan **INVITED**

Since the report of high entropy alloy (HEA), other high entropy materials such as high entropy oxide (HEO), carbide, nitride, fluoride , etc. are being intensively investigated. These new materials were synthesized to have different forms, e.g., film, bulk, or powders. Although limited, these studies have shown interesting results that demonstrate the use of these new materials in different applications including energy storage and catalysis. Here, we report HEO nanopowders produced using a facile synthesis method. HEOs having various groups of 5 elements with different elemental concentrations are reported. The resulting materials were subjected to various microstructural analysis. Depending on the composition, different single crystal structures were obtained. Homogeneous elemental distributions were also obtained. Selected HOE nanopowders were evaluated for use as anode in lithium ion battery and electrode in water splitting cell. Exceptional properties are reported and discussed.

12:45pm **LI-ThM2-8 Closing Remarks & Thank You's!**, ***Glen West (g.west@mmu.ac.uk)***, Manchester Metropolitan University, UK

We hope you enjoyed the Session and will join us for the Post-Live Session for additional Q&A opportunities! We will see you tomorrow!

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