Monday Afternoon, May 12, 2025

Keynote Lectures
Room Town & Country A - Session KYL-MoKYL

Keynote Lecture I

Moderator: Dr. Ivan G. Petrov, University of Illinois at Urbana-Champaign, USA

1:00pm **KYL-MoKYL-1 Bill Sproul Award and Honorary ICMCTF Lecture: Robust Plasmonically-Active Nanoscale Multilayer TiN/NbN Coatings***,* *Arunprabhu Sugumaran Arunachalam Sugumaran,* Sheffield Hallam University, United Kingdom*; Ryan Bower, MIng Fu,* Imperial College London, UK*; David Owen, Papken Eh. Hovsepian,* Sheffield Hallam University, UK*; Peter K. Petrov, Rupert Oulton,* Imperial College London, UK*; **Arutiun P. Ehiasarian [A.EHIASARIAN@SHU.AC.UK]**[1],* Sheffield Hallam University, UK **INVITED**

Plasmonic catalysis enabled by visible light is vital to enhancing the activity of surfaces in promoting a broad range of chemical reactions including water splitting and associated production of bioactive reactive oxygen species.However standard catalysts that rely on nanoparticles are not sufficiently robust for deployment in the environment.Transition metal nitrides are promising candidates whose function is highly dependent on their purity and structure.High-Power Impulse Magnetron Sputtering has been deployed to tailor the texture and morphology of nanoscale multilayer TiN / NbN coatings and evaluate the effect of their plasmonic activity.Plasma characterisation show a significant fractions of dissociated nitrogen and double-charged metal ions in both TiN and NbN deposition conditions.Time-resolved ion energy distribution functions obtained from energy-resolved mass spectroscopy indicate that 30% of dissociated nitrogen possesses a high-energy tail and originates from sputtering from the target surface alongside Ti and Nb thereby increasing adatom mobility and intergranular density and promoting a strong (200) fibre texture as observed in pole figures.Nevertheless oxidation of the surface detected through XPS deteriorated the plasmonic performance of the films as observed through ellipsometry.Pump-probe laser measurements showed significant increases in the lifetime of active electron species in the films due to trapping of hot carriers in oxygen vacancies such as Nb^{3+} and Ti^{3+}., with Nb being more sensitive due to a higher enthalpy of its oxide. Nanoscale multilayer films deposited with small bi-layer thickness of 1.7 nm exhibited strong intermixing between the TiN and NbN layers which led to small grain size observed by AFM and longer hot carrier lifetime.Bilayer thickness of 2.4 and 3.5 nm led to doubling of the grain size and shorter hot carrier lifetimes.A graded structure, starting from a bilayer thickness of 2.4 and reducing to 1.7 nm exhibited a large grain size and increased hardness and toughness as determined from nanoindentation. Ellipsometric measurements of the real component of the dielectric permittivity confirmed an excellent plasmonic activity.The effects of carrier lifetime on photocatalytic activity are discussed.The results pave the way to using nanosale multilayer coatings for catalysis.

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[1] **Bill Sproul Awardee**

Keynote Lectures
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Keynote Lecture II
Moderator: Dr. Peter Kelly, Manchester Metropolitan University, UK

1:00pm **KYL-WeKYL-1 Spatial Atomic Layer Deposition for High Throughput Industrial Production of Lithium-Ion Batteries and Photovoltaic Cells***, Tommi Kääriäinen [tommi.kaariainen@beneq.com],* Beneq, USA **INVITED**

Atomic Layer Deposition (ALD) is an enabling thin film technology which found its use in energy applications such as energy storage (Li-ion batteries) and PV applications (TOPCon and perovskite PVs). Thin oxide coating deposited by ALD has been shown to improve battery performance through the introduction of thin film coatings to modify interface surfaces on cathodes, anodes and separators. ALD can help to improve thermal stability, stabilize Solid Electrolyte Interphase (SEI), suppress dendrite growth, inhibit transition metal dissolution, and increase interfacial contact between layers, all of which are current issues facing lithium-ion battery technology. ALD SnO2 has been a material of choice for electron transport layers (ETL) of perovskite based solar cells and Al2O3 as a passivation layer for TOPCon solar cells.

Spatial ALD (SALD) is an advanced coating technique, which has been studied for more than 10 years for various applications. We will demonstrate how SALD technology can be used to scale-up the throughput of ALD technology used in battery and PV applications.

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