Plasma and Vapor Deposition Processes
Room Palm 5-6 - Session PP2-3-FrM

HiPIMS, Pulsed Plasmas, and Energetic Deposition III

Moderators: Arutiun P. Ehiasarian, Sheffield Hallam University, UK, **Tetsushide Shimizu**, Tokyo Metropolitan University, Japan

8:00am **PP2-3-FrM-1 Experiments and Modelling of High Power Impulse Magnetron Sputtering Discharges with Metallic Target***, **Jon Tomas Gudmundsson [tumi@hi.is]**, Kateryna Barynova,* University of Iceland*; Martin Rudolph,* Leibniz Institute of Surface Engineering (IOM), Germany*; Joel Fischer,* Linkoping University, Sweden*; Tetsuhide Shimizu,* Tokyo Metropolitan University, Japan*; Daniel Lundin,* Linkoping University, Sweden

High power impulse magnetron sputtering (HiPIMS) discharges with a number of metal targets have been explored experimentally followed by a further study using the ionization region model (IRM). The metal targets studied include, tungsten [1], chromium [2], zirconium [3], titanium [4], and copper [5]. Experimentally, the ionized flux fraction has been found to be in the range 10 - 80 %, and it is found to increase with increased discharge current density, and decreased working gas pressure. However, the deposition rate generally decreases with increased peak discharge current density. There is a trade off between high ionized flux fraction and high deposition rate, sometimes referred to as the HiPIMS compromise. An overview will be given on the experimental results for various target materials and dependence on varying operating parameters such as peak discharge current density and pulse length. The IRM allows for studying the temporal evolution of the discharge current composition, the electron power absorption mechanisms, the ionization and back-attraction probabilities of the sputtered species, the dominant recycling mechanism, and the working gas rarefaction. We discuss how the discharge current composition varies between different target materials, and how the recycled species, and the processes leading to working gas rarefaction, depend on the target sputter yield [4]. In particular we will discuss how the back-attraction probability of the sputtered species depends on the sputter yield of the target material [7].

[1] Swetha Suresh Babu et al., Plasma Sources Science and Technology, 31(6) (2022) 065009

[2] K. Barynova et al. Plasma Sources Science and Technology, submitted 2025

[3] Swetha Suresh Babu et al., Journal of Vacuum Science and Technology A, 42(4) (2024) 043007

[4] T. Shimizu et al. Plasma Sources Science and Technology, 30(4) (2021) 045006

[5] J. Fischer et al., Plasma Sources Science and Technology, 32(12) (2023) 125006

[6] K. Barynova et al., Plasma Sources Science and Technology, 33(6) (2024) 065010

[7] K. Barynova et al., Plasma Sources Science and Technology, 34(6) (2025) 06LT01

8:20am **PP2-3-FrM-2 Knowing and Controlling the Dynamic Plasma Potential and Sheath Voltage as Key Elements in Plasma-Based Deposition***, **André Anders [andre.anders@plasmaengineering.com]**,* Plasma Engineering LLC, USA **INVITED**

It is widely known that a space charge layer exists between plasma and a surface (target, substrate, wall, probe, etc.) which is called the sheath.The sheath voltage is the difference between the surface potential and the potential at the sheath edge, the boundary between plasma and sheath. Space charge is linked via the Poisson equation to an electric field which governs fluxes of charged fluxes and thereby energy delivered to the surface.There is nothing new so far, but in real life, for practical reasons, one uses (earth) ground as the reference, not the plasma potential.This can lead to confusion, especially as the plasma potential is not constant in space and time when using modern approaches to plasma-based deposition that involves magnetic fields and pulsed processing, such as bipolar HiPIMS.In this contribution, the establishment of plasma potential, or better the dynamic plasma potential distribution, will be explored and the consequences for film growth discussed.The local and dynamic plasma potential can be associated with numerous effects such cathode spot and anode spot formation (a.k.a. “arcing” and “fireball” in magnetron systems, respectively), the control of ion and electron flows, which affect a growing film’s microstructure, and also with unwanted effects such as sputtering of and arcing on chamber walls and other grounded components.Knowing and controlling the dynamic plasma potential and sheath voltage is therefore important to plasma-based deposition processes.

9:00am **PP2-3-FrM-4 Electrocatalytic Performance of AlCrCoNiFeX (X = C, O)HighEntropy Alloy Films for Oxygen and Hydrogen Evolution Reactions***, **Amna Waheed [amnawaheed146@gmail.com]**,* Ming Chi University of Technology, Taiwan*; Bih-Show Lou,* Chang Gung University, Taiwan*; Jyh-Wei Lee,* Ming Chi University of Technology, Taiwan

The growing demand for sustainable and efficient energy conversion technologies has intensified interest in developing advanced electrocatalysts for water splitting. Highentropy alloys (HEAs), composed of multiple principal elements in near-equiatomic ratios, offer a promising platform due to their unique compositional flexibility, tunable electronic structure, and synergistic catalytic effects. In this work, AlCrCoNiFeX (X = carbon and oxygen) HEA films were synthesized via reactive HiPIMS to assess their bifunctional electrocatalytic activity for the oxygen and hydrogen evolution reactions (OER and HER) in alkaline media. The carbon and oxygen contents were systematically varied to study their combined effects on the structural, morphological, and electrochemical properties of the deposited HEA films. The enhanced catalytic behavior can be ascribed to the synergistic interactions among multiple metallic constituents and the optimized surface structure resulting from carbon–oxygen–carboxylic incorporation. Electrochemical evaluations, including linear sweep voltammetry (LSV), electrochemical impedance spectroscopy (EIS), and double-layer capacitance (C_{dl}) measurements, confirmed the superior charge transfer kinetics, larger electrochemically active surface area, and improved catalytic efficiency of the optimized composition. Furthermore, long-term stability and durability tests demonstrated excellent sustainability of the catalyst under continuous operation, validating its structural robustness and electrochemical reliability. This study highlights the potential of AlCrCoNiFeXHEA films as a new generation of efficient and durable bifunctional electrocatalysts for practical water-splitting applications.

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