

## **Metal Deposition Assisted by UPD Monolayers-Fundamentals and Applications**

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The improved understanding of nucleation and growth kinetics provides the base for design of new experimental approaches where the thin film growth is manipulated to enhance the evolution of atomically flat epitaxial overlayers. Following this progress, a new protocols for electrochemical thin film growth were developed which benefit from the Underpotentially Deposited Monolayers (UPD ML) serving as a surfactants (SMG), flux mediators (DMG) or sacrificial templates (SLRR) in deposition process of thin films. In these examples, the 2D growth is achieved by precise control of the electrode potential, electrodeposition sequence and/or solution chemistry which enable particular action/benefit of the UPD ML to be fully exploited in the growth process.

In the first part of the talk we briefly review fundamentals of the electrochemical thin film growth assisted by UPD ML. Our results and discussion are focused on examining the extendibility of UPD assisted growth approach. Results focus on for technologically relevant systems such as synthesis of Pt ML catalyst and growth of Cu/Ru(hklm) thin films. Fundamental relations between experimental conditions and resulting morphology of Pt ML catalyst are reviewed as well as the results demonstrating that 2D growth of Cu on Ru can be radially achieved using UPD assisted electrodeposition methods.

In the second part of the talk we demonstrate a new phenomenon of electroless (e-less) Pb ML deposition. The application of this phenomenon is demonstrated through the example of improved morphology and magnetic properties of e-lessly deposited Co overlayers on Cu assisted by e-lessly deposited Pb ML serving as surfactant. The phenomenon of e-less UPD-like ML deposition as a prelude for e-less atomic layer deposition (E-less ALD) are discussed as well using the example of Pt ML catalyst synthesis and growth of Pt films on Cu substrate.

## **Taloženje metala na monoslojevima istaloženim na potpotencijalima – osnove i primena**

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Dobro poznavanje kinetike nukleacije i rasta pri elektrohemjskom taloženju metala predstavlja osnovu za dizajniranje novih eksperimentalnih pristupa taloženju tankih filmova sa izraženom strukturom atomski ravnih epitaksijalnih slojeva. U tom cilju razvijeni su novi elektrohemijski postupci rasta tankih filmova primenom potpotencijalnog taloženja monoslojeva koji služe kao surfaktanti, medijatori fluksa ili žrtvujuće strukture. Dvodimenzioni rast filma se postiže preciznom kontrolom elektrodnog potencijala, redosledom taloženja i/ili hemijskim sastavom rastvora, što doprinosi tome da monosloj metala istaloženog na potpotencijalu bude u potpunosti iskorišćen u procesu rasta filma.

Prvi deo predavanja posvećen je kratkom pregledu elektrohemijskog taloženja tankih filmova potpomognutog prethodno formiranim monoslojem na potpotencijalima. Rezultati i diskusija su fokusirani na ispitivanje mogućnosti proširenja primene ove metode taloženja metala i to prvenstveno u tehnološki značajnim procesima kao što su sinteza monoslojeva platine kao katalizatora i rast tankih filmova bakar/rutenijum(hkml). Dat je pregled osnovnih relacija između eksperimentalnih uslova i dobijene morfologije katalizatora platine, kao i rezultata koji pokazuju da se dvodimenzioni rast bakra na rutenijumu može lako ostvariti primenom pomenute metode.

Drugi deo predavanja odnosi se na novi fenomen spontanog taloženja monosloja olova. Primena ovog fenomena pokazana je kroz primer poboljšanja morfologije i magnetnih karakteritika spontano taložene prevlake Co na Cu potpomognute spontano taloženim monoslojem olova koji služi kao surfaktant. Fenomen spontanog taloženja monosloja, sličnog onom taloženom na potpotencijalima, koji služi kao priprema za spontano taloženje atomskih slojeva, razmatran je takođe i na primeru sinteze monosloja Pt kao katalizatora i rasta Pt filmova na Cu podlozi.

## Curriculum Vitae



Stanko R. Brankovic is professor at the Cullen College of Engineering, University of Houston. He obtained B.E. in Chemical and Biochemical Engineering in 1994 (University of Belgrade) and Ph.D. in Science and Engineering of Materials in 1999 (Arizona State University). Before joining the University of Houston in 2005, he spent two years as postdoctoral researcher at Brookhaven National Laboratory (1999-2001) and four years as a research staff member at the Seagate Research Center in Pittsburgh (2001-2005).

Dr. Brankovic currently serves as the Chair of the Electrodeposition Division. He also served as the chair of Electrochemical Material Science Division of the International Society of Electrochemistry (2015-2017). His work has been acknowledged by University of Houston Research and Excellence Award (2010) and National Science Foundation Faculty Early Career Development Award (2010). He is also recipient of the 2017 Electrodeposition Research Award of the Electrochemical Society and 2018 AIChE Award for the Best Fundamental Paper. More information about Dr.

Brankovic's group and research interests are available at: <http://ecnfg.ece.uh.edu>.

## Biografija

Stanko R. Branković je redovni profesor Univerziteta u Hjustonu, Cullen College of Engineering. Na Univerzitetu u Beogradu stekao je zvanje diplomiranog inženjera hemijskog i biohemijskog inženjerstva 1994. godine, a 1999. godine zvanje doktora nauka na Arizona State University u oblasti inženjerstva materijala. Pre dolaska na Univerzitet u Hjustonu dve godine proveo je u Nacionalnoj laboratoriji u Brukhejvenu kao post-doktorand (1999-2001), i četiri godine kao istraživač u Seagate Research centru u Pitsburgu (2001-2005).

Prof. Branković je trenutno predsednik Odeljenja za elektrodepoziciju u okviru Međunarodnog elektrohemijskog društva (ISE), a bio je i predsednik Odeljenja za nauku o materijalima (2015-2017). Za svoj rad dobio je nagradu Research and Excellence Award 2010. g. od strane Univerziteta u Hjustonu, kao i nagradu National Science Foundation Faculty Early Career Development Award (2010). Takođe je dobitnik nagrade Electrodeposition research Award (2017) elektrohemijskog društva (ECS) i nagrade Best Fundamental Paper AIChE Award 2018. Više informacija o grupi i oblasti istraživanja dr Brankovića dostupno je na linku <http://ecnfg.ece.uh.edu>.