

CAREER: Electrochemical Nanofabrication – The Transformative Concept towards Synthesis of Novel Materials, Functional Surfaces and Metallic Nanostructures

In the last several decades, the electrochemical processes were proven to be one of the enabling fabrication routes behind the train of nano-technology enterprise. The devices with sub-100 nm dimensions are commonly produced using the electrodeposition and electropolishing as standard processing operations. In recent years, electrochemical methods were used to grow variety of multilayered metallic thin films and nano-structures. There are many other examples where the electrochemical fabrication is used as convenient if not “*the only*” approach to deliver the desired structures, materials or catalytic surfaces. The traditional fields of electrochemical research like corrosion, or electrodeposition are rapidly being involved in different contemporary scientific disciplines where the word “*nano*” is frequently used prefix.

Intellectual Merit. The proposed career development program represents a unique synergy between the fundamental science of *metal deposition via surface controlled red-ox reaction, dealloying and surface electrochemistry* and their application to the related fields of electrocatalysis, thin films, sensors and nanofabrication. For the first time the most important thermodynamics quantities controlling deposit morphology obtained *via surface controlled red-ox reaction* will be identified and studied in very detail. In addition to that, the kinetic aspects of electrochemical thin film growth will be examined and the dominant atomistic processes defining the thin film morphology will be revealed. The dealloying of binary alloys will be examined as the fabrication method for synthesis of the ultrasound sensor materials. The proposed research plan capitalizes on advantages that *metal deposition via surface controlled red-ox reaction* provides to produce model system for studies of other fundamentally important questions in electrocatalysis and surface science which until this moment were mostly confined to experiments in vacuum. The proposed work will study metallic low-dimensional and nanoporous structures and evaluate their application through the scope of advanced nanoscale catalyst design, and ultrasound sensor design. PI of this proposal has experience and diverse background to carryout this research as the main direction of his future carrier development. The previous experience of PI in fields of electrodeposition, electrocatalysis and nanofabrication is illustrated by his co-authorship in 30+ peer reviewed publications and 3 patents.

Broader Impact. The great potential of this program is in many applications and connecting research directions that could evolve. The concept that will be developed and fundamental science that will be revealed in this work will be extended to many other scientific disciplines. The self organized 2D metal structures, design of catalyst monolayers or organized growth of carbon nanotubes are just some of the examples. This program integrates educational component, which spans from high school beginners to graduate students, with the cutting edge research into sustainable structure. The long term goal of this program is to produce the highly qualified scientist and engineers able to carryout the technical challenges of the modern world.