Award Details

Electrochemical dynamics of nanoparticles suspended in an ionic liquid or organic ionic plastic crystal

Research Details

Competition Year:	2019	**Fiscal Year:**	2020-2021
Project Lead Name:	Stockmann, Talia	**Institution:**	Memorial University of Newfoundland
Department:	Chemistry	**Province:**	Newfoundland and Labrador
Award Amount:	29,000.00	**Installment:**	4 - 5
Program:	Discovery Grants Program - Individual	**Selection Committee:**	Chemistry
Research Subject:	Electrochemistry	**Area of Application:**	Physical sciences
Co-Researchers:	No Co-Researcher	**Partners:**	No Partners

Award Summary

The main objective of our research program is the development of multi-purpose, flexible/mouldable electrode and electrolyte materials for health, energy storage, and catalytic applications. Long-term objectives will be towards evaluating nanocomposite materials incorporating plastic bulk material properties with embedded metal nanoparticles (NPs) for enhanced reactivity as well as improved ionic and electronic conductivity. Since electrode reactions are heterogeneous, occurring at either solid|solution or immiscible liquid|liquid interfaces, understanding interfacial reaction mechanisms and kinetics/thermodynamics is crucial for optimizing electrode material performance. This is complicated by the surface morphology (e.g. roughness), which inhibit or enhance species adsorption. To deconvolute interfacial reactions, we will use high-resolution (nanoscale) electrochemical imaging, which images surface electroactivity and topography, simultaneously in situ and in operando. These nanoprobes are capable of distinguishing single NPs. Physicochemical and electrocatalytic information is in turn a direct measure of device performance. In this way, we will assess material suitability and fill gaps in fundamental physical/material chemistry knowledge. Combined with conventional electrochemical methods (e.g. cyclic voltammetry and impedance spectroscopy), we will develop predictive models of nanocomposite material performance, which will enable us to develop new technologies and new scanning probe methodologies. We will also install electroactive materials into our nanoprobes to make highly sensitive proof-of-concept (bio)sensors. For NPs suspended in liquid media, we will employ techniques such as single NP tracking in tandem with stochastic NP impact detection to elucidate NP reactivity and NP generation/destruction processes. Short-term objectives will focus on metal NPs embedded in ionic liquids (ILs) or organic ionic plastic crystals (OIPCs). ILs are liquid at room temperature, while OIPCs are plastic. Through our scanning probe methods, we will gain insight into NP-NP and NP-IL/NP-OIPC interactions. We will explore simple one-step charge transfer processes, up to multi-step electrocatalysis. The impact of NPs on the physicochemical and morphological properties of IL and OIPC films will also be investigated, where they have been shown to enhance viscosity and the formation of defects/grain boundaries, respectively. These in-turn enhance ionic and electronic conductivity. The role of NPs in electrocatalysis in OIPC is virtually unexplored and will be a major focus of the research team at Memorial. Our work will contribute to Canada's leadership in the fields of electrocatalysis, advanced sensing, energy storage/harvesting, high resolution scanning probe imaging, and optical spectroscopy. HQP will develop highly valued electroanalytical, scanning probe, computational, synthetic, and materials characterization skills.