Graduate Student Research Seminar

Fall 2023

Exploring System Limitations in Nickel Electrodeposition

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Monday, October 2nd
3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Widely used in manufacturing for creating heat shields, thin-shell engines, and microelectronic devices, electrodeposition enables the repeatable production of metal parts with a high level of precision by controlling the rate and distribution of atomic deposition. Electrodeposition research tends to focus on how to modify the starting parameters to push the electrochemical phenomena into optimal conditions rather than defining how they are created by the parameters. Computer models also show an inability to accurately predict the starting parameters for a component with given characteristics of strength, stress, and geometry. Extensive process iterations have improved deposition uniformity, but there is still a need to clarify the chemical cycle of the system and its energetic implications. We use a nickel watts bath, a commonly used industrial chemical bath, as a model system to investigate the foundational interactions of the electrodeposition cycle. This information will then be processed to create a comprehensive computational model that can be used to optimize future electrodeposition systems without requiring experimental iterations. Initial research includes setting up the electrodeposition system and gaining familiarity with the system's limitations. A stainless steel substrate is immersed in the super-concentrated nickel solution with a nickel anode. The circuit is then subjected to various voltages, frequencies, and temperatures, with the resultant deposition characterized visually. Computational simulations use COMSOL. These simulations first illustrate the basic behavior of the system, followed by continuous tailoring to simulate experimental parameters. These results allow for system tailoring, both experimentally and computationally, to begin investigating fundamental phenomena.

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