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Water-in-Salt Electrolytes

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A novel electrolytic medium called Water-in-Salt Electrolyte for electrodeposition is gaining widespread attention among the Electroplating community worldwide. The Water-in-Salt Electrolytes (WiSE) use a very high salt concentration and very little water. This changes the behaviour of such electrolyte by suppressing hydrogen and oxygen evolution and widening the usable electrochemical window. As a result, WiSE can support safer and more efficient aqueous electrochemistry than ordinary water-based solutions. It also helps reduce oxide, hydroxide, and dendrite formation thereby making it a promising material for batteries, energy devices and electroplating and Metal finishing. (S. De, W.D. Sides, T. Brusuelas , Q, Hunag, J. Electroanal. chem., 113889, (860), 2020).

WiSE is now being explored beyond energy storage. It is useful for depositing metals that are difficult to plate from normal aqueous baths. These include highly reactive metals and some rare-earth elements. Traditional methods for such metals often rely on molten salts or ionic liquids. Those methods can involve high temperatures, safety risks, or stability problems. WiSE offers a simpler water-based alternative. It keeps many advantages of aqueous systems while improving voltage range and deposition control. Recent studies show several interesting results. WiSE has enabled reversible zinc deposition, which is important for tunable optical coatings. It has also supported alloy deposition and the growth of superconducting rhenium films. In these cases, hydrogen evolution was strongly reduced, and the films showed better stability.

Prof. Qiang Huang at University of Alabama, USA is studying the electrochemical behavior of rare earth elements in Water-in-Salt Electrolytes (WiSE) in order to develop rare-earth-containing coatings with tailored properties and functionalities. The project uses WiSE as the main electrolyte system, with deep eutectic solvent "ethaline" (choline chloride:ethylene glycol, 1:2) and acetate-salt aqueous electrolytes as benchmarks for comparison. (http://short.pfonline.com/NASF26-Jan3; http://short.pfonline.com/NASF26-May2).

In the first phase, the work focused on developing small, detachable Rotating Disk Electrodes (RDEs). This led to the development of an experimental platform that enables electrochemical measurements in very small electrolyte volumes. Several fabrication approaches for such RDEs were evaluated. Subsequently, preliminary deposition studies of Co, Ni, and Cu using a 1 mm Pt RDE in ethaline were performed, with the respective metals as anodes and a silver wire as reference electrode, laying the groundwork for adding rare earth metals into Ni or Co electrolytes for alloy deposition and for parallel studies in acetate-salt water-based electrolytes.

At a time when rare earth minerals are gaining world wide attention, these studies have gained greater importance in order to exploit their unique material properties.

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