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Title: REDOX FLOW BATTERY HAVING METAL-LIGAND COMPLEX

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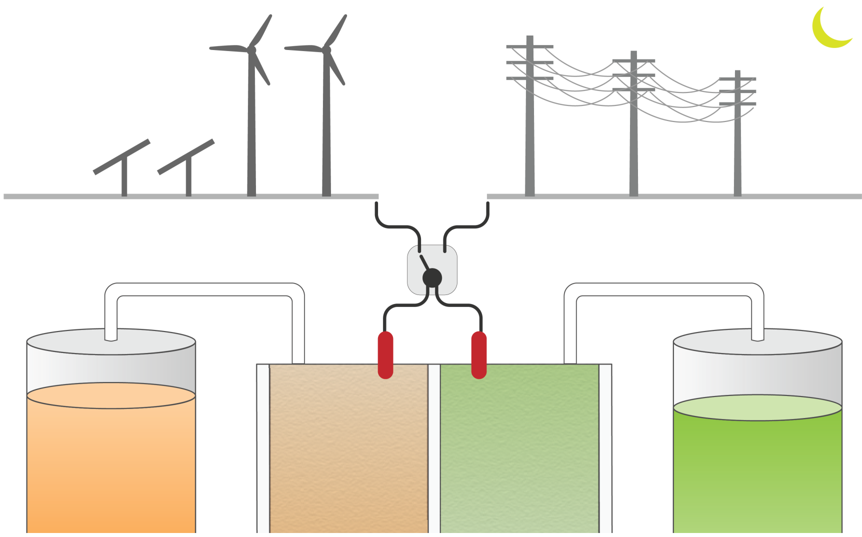

Tech Snapshot

Chemistry

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REDOX FLOW BATTERY HAVING METAL-LIGAND COMPLEX

SUMMARY

Researchers at Los Alamos National Laboratory have developed new non-aqueous electrolyte materials for redox flow batteries (RFB). These batteries are a viable technology for scalable energy storage beyond lithium ion batteries. Cost is currently limiting deployment, with poor energy density being the primary culprit. One way to improve energy density is by increasing the cell potential beyond the current limit in aqueous media. The higher cell potential and additional electrons stored per molecule will increase the energy density of the RFB medium, overcoming a critical limitation to the current RFBs. Like lithium ion batteries, RFB's can span from the kW to multi MW power storage systems. The nickel complexes described herein have demonstrated redox potentials >3 V which is at least twice the aqueous limit. We are interested in partnering with battery developers to further advance this technology to the product prototype stage.

MARKET APPLICATION

The global redox flow battery (RFB) market was valued at USD 187.7 million in 2017 and is expected to reach USD 946.3 million by 2023. The market can be segmented into type, material, storage, application, and region. In the US, the largest market sector growth for RFBs is expected to be for micro-grids. A micro-grid generally operates while connected to the grid, but importantly, it can break off and operate on its own using local energy generation. A micro-grid provides backup for the grid and can connect to a local resource that is too small or unreliable for traditional grid use. The modularity and ease of scaling of RFBs is a good match to the widely variable storage requirements of micro-grids. Additionally uninterruptable power supplies, energy arbitrage and frequency regulation applications are near-term, though smaller, emerging markets for RFBs.

BENEFITS

Like other true RFBs, the power and energy ratings of the system are independent of each other, and each may be optimized separately for each application. This technology provides the following benefits:

- Non-aqueous electrolyte systems may reduce cost by achieving higher cell potentials and greater power density
- Storage capacity scales with electrolyte volume, can yield up to 3x runtime increase over Li-ion battery
- Modular design allows for adaptability that can increase storage capacity or power output.
- True redox flow battery making energy and power capacities independently variable.

CONTACT

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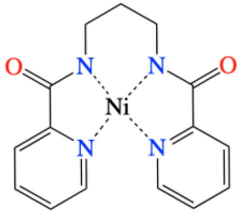
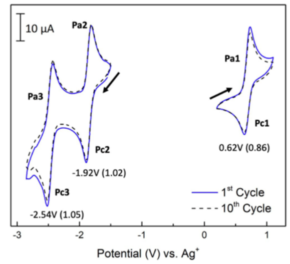
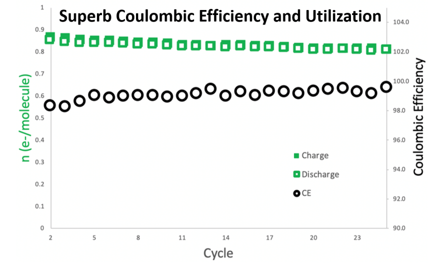


Ni(bppn)





WHY WE ARE BUILDING REDOX FLOW BATTERY HAVING METAL-LIGAND COMPLEX

Los Alamos has a history of using its core capabilities to support DOE's energy mission, a symbiotic relationship that has contributed innovative solutions to energy, while enriching the technical base that Los Alamos needs to achieve its mission. Redox flow batteries promise greater economy than lithium ion batteries, but the higher volumetric energy density of a conventional RFB is a barrier to deployment that this innovation directly overcomes.

WHAT'S BEHIND OUR TECHNOLOGY

We targeted several multi-dentate ligand motifs to meet the diverse performance criteria of charge carriers in RFBs. One example is propyl group bridging two picolinic amides. When complexed with nickel, the resulting species exhibits promising reversible redox features. If a RFB is made using this charge carrier, the resulting improved cell potential > 3.0 V and the negative electrolyte (negolyte) can store more electrons/ligand-metal complex.

OUR COMPETITIVE ADVANTAGES

These new chemistries should have the requisite increase in durability and reduced cost, thus a RFB based on this discovery could be implemented into kilowatt to megawatt scale energy storage system, which can replace lithium ion batteries directly due to their better matched volumetric energy density. this also results in tripling the RFB run times between recharges as compared to Li-ion batteries.

OUR TECHNOLOGY STATUS

Multiple non-aqueous electrolytes and metal-ligand complexes have been developed for evaluation as RFB redox carriers at Los Alamos National Laboratory. We are interested in partnering with battery developers to further advance this technology to the product prototype stage.

PUBLICATIONS AND IP

S133576.001, "Redox flow battery having ligand-metal complex", U.S. Pat. Appl. No. 15/999036, Appl. Date: 08/17/2018.

S133701.001, "Ligands and their derived metal complexes for applications in redox flow batteries", U.S. Pat. Appl. No. 16/824465, Appl. Date: 03/19/2020.

"Linked Picolinamide Nickel Complexes as Redox Carriers for Nonaqueous Flow Batteries", ChemSusChem ; (2019).

"*Impact of Ligand Substitutions on Multielectron Redox Properties of Fe Complexes Supported by Nitrogenous Chelates*": ACS Omega ; Vol.3, iss.11, p.14766-14778, 2 November 2018