

TECHNOLOGY FACT SHEET

IMPROVED ELECTROLYTES FOR LITHIUM/AIR BATTERIES

(Read)

Introduction

The invention is a significant improvement in achieving batteries with higher energy density. A researcher at the U.S. Army Research Laboratory–Sensors and Electron Devices Directorate (ARL-SEDD) in Adelphi, Maryland identified and tested a series of electrolytes and electrolyte solvents that enhance the utility of lithium/air (Li/Air) cells. Li/Air has approximately twice the theoretical energy density of widely-available lithium/mono-carbon fluoride batteries (Li/CFx). The adaptation of Li/Air to common battery formats such as the BA 5590 shown below (**Source: Department of Defense**) could decrease present weight and size of such devices by 50 percent.



Replacing Li/CFx cells with Li/Air could reduce the size and weight current BA 5590 battery (left image) by half (right image)

Concept

Metal/air batteries utilizing alkali and alkaline earth metal anodes are very popular because the cathode active material, oxygen, does not have to be stored in the battery but can be accessed from the environment. This makes the battery much lighter, smaller and more energy dense. The potentially very high energy density of the Li-air battery has spurred considerable recent interest in developing it for a large number of applications, including renewable energy (RE). In RE applications, batteries store generated energy for later use and improve grid stability by acting as a buffer to compensate for the intermittent nature of renewable energy resources. Li/Air batteries, with such a large energy capacity, can play a significant role in reducing the footprint of energy storage, and the ARL electrolyte improves the performance of such cells.

Invention Overview

- ❖ Novel electrolytes and electrolyte solvents significantly improve energy storage capacity and discharge rate capability
- ❖ Can be practiced with existing Li/Air cell configurations and is applicable to other metal/air battery designs
- ❖ TRL 4 – Functional laboratory cells and test data available
- ❖ U.S Patent 7,585,579

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- ❖ ARL-SEDD is a leader in partnering with domestic firms
- ❖ Successfully developed and implemented innovative tools to ease the technology transfer process
- ❖ Tools includes Patent License Agreements (PLAs); Cooperative Research and Development Agreements (CRADAs); Test Services Agreement (TSA); and others
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Features/Capabilities/Intellectual Property

Metal/Air batteries using aqueous electrolytes are well known with iron/air, zinc/air and aluminum/air being the most studied. In particular the zinc/air battery has been commercialized, primarily for hearing aid devices and pagers. However, as shown in the chart below, the Li/Air has drawn significant attention due to its high energy density, much greater than other Metal/Air combinations and other popular Li battery chemistries. The advantage of the ARL invention is that charge capacity and discharge rate capability of presently known Li/Air devices can be improved by the composition of the electrolyte, which focuses on the solubility of oxygen. Capacity and rate capability have been shown as being directly influenced by the ability of the electrolyte to dissolve increased amounts of oxygen. The ARL invention offers a series of electrolyte solutions that are stable in organic solvents and have demonstrated significantly-improved battery performance. Other features/capabilities/intellectual property offered by the ARL invention include the following:

- Uses materials common to the industry
- Fits existing cell configurations
- IP includes novel composition of matter (electrolytes), assembled device (Li/Air and Metal/Air batteries) and method for optimizing the composition of an electrolyte.

Cell Electrochemistry	Theoretical Gravimetric Energy Density (watt hours/kilogram)
Zn/Air	1,353
Mg/Air	6,800
Al/Air	8,100
Li/Air	13,000
Li/SO ₂	1,170
Li-Ion	410

Potential Markets/Applications

Although there are a number of technical issues to be solved before the first commercial Li/Air battery hits the market, the increasing number of companies entering the field is an indicator of the enormous potential of this “holy grail” of battery chemistries:

- Grid Load Management – Utilities can store electricity generated during off-peak periods to meet demand during high-peak operation
- Back-up Power Supplies for Communities
- Cost Management – Industrial customers can store off-peak, lower-priced power for use during high-priced, peak-demand times.

Key Advantages & Benefits

- ❖ Includes method of selecting electrolytes to improve capacity and rate capability of Li/Air cells using organic electrolytes
- ❖ Uses materials commonly available in battery industry
- ❖ Expected to cost similarly to existing electrolytes
- ❖ ARL Inventor team available to work with commercialization partner

Contact Information

This technology was developed by ARL-SEDD. It is now available for licensing and CRADA opportunities.

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