

Battery System and a Method of Forming a Battery

Energy & Environment

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Electricity and Power Electronics Energy Conservation/Generation/Management/Storage (Battery)



Concept

Fig. 1. Schematic of stainless-steel/lithium system.

Cathode	Potential (V vs. Li/Li ⁺)	Capacity (mAh g ⁻¹)	Energy density (Wh kg-1)
LiCoO ₂	3.7	~150	555
LiMn ₂ O ₄	4.0	~100	400
LiNi _{0.5} Mn _{1.5} O ₄	4.8	~120	576
M/M ⁺ Cl [−]	~2.8	248 (e.g. Ag)	694
M/M ²⁺ Cl ²⁻	~2.5	959 (e.g. Fe)	2397

Table 1: Comparison of potential, capacity and energy density of cathode materials. The ones in current invention are in Bold.

Opportunity

Lithium-ion batteries are widely used in a variety of products such as cell phones, EVs, and large stationary storage. However, existing lithium-ion technologies only support an energy density of about 250 W h kg+1, and this is due to the limited amount of lithium ions that a battery cathode can hold.

Build Value

The invention described here is a novel battery technology that uses chloride ions to assist electron transfer during charge and discharge. This allows the battery to avoid using lithium as a material. With its higher energy density, this battery will dramatically impact industries such as electronics, transportation, and energy supply, as batteries will be able to last longer with each charge. At the same time, renewable energy systems that rely on battery storage will become more affordable.

Technology

Battery technology relies on energy being stored through the controlled release of metal ions into an electrolyte solution. Traditionally, battery cathodes have relied on lithium as a source of ions, but the problem with lithium is that only a limited amount of it can be inserted into cathode material, thus leading to low energy density.

This invention can use a wide variety of metals as a cathode material, including metals such as silver, iron and copper that have much higher theoretical capacities. Lithium is not necessary in the cathode since this invention relies on chloride ions as the charge carrier. The invention also uses an alkali-metal anode that produces high voltage and high energy density. The invention can store energy in two ways: either through the formation of insoluble metal chlorides or through the release of ions in an electrolyte solution.

Advantages

- This invention has an expected practical energy density that is 2-2.5 times greater than that provided by current lithium ion technologies.
- The similarity of this technology to current lithium-ion technologies means that it can easily achieve widespread adoption.

Applications

- Mobile devices
- Electronic vehicles
- Renewable energy systems that rely on battery storage

Additional information

- H. Wang, W. Gu, <u>D. Y. W. Yu</u>^{*} "Demonstrating a metal-metal battery system in aprotic electrolyte with Ag and Li" *ChemElectroChem* (2019) 6, ncept 3627-3632. DOI: 10.1002/celc.201900969
- H. Wang, <u>D. Y. W. Yu</u>^{*}, "Stainless Steel as Low-Cost High-Voltage Cathode via Stripping/Deposition in Metal-Lithium Battery" *Electrochim. Acta* (2019) 298, 187-193. DOI: 10.1016/j. electacta.2018.12.064