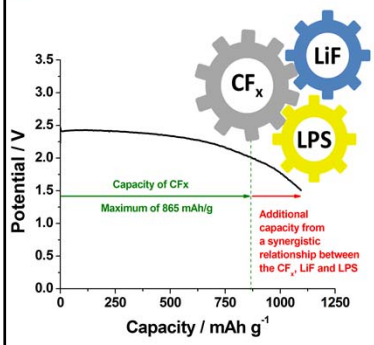
A Bi-functional Electrolyte Design for Long Lasting Batteries



The cathode (CF_x), electrolyte (Li_3PS_4) and the product of discharge (LiF) operate synergistically to deliver ultra high capacity exceeding the theoretical capacity of conventional Li-CF_x batteries.

Materials synthesis, cell assembly and testing were performed as a user project at the Center for Nanophase Materials Sciences.

Scientific Achievement

A novel design of bi-functional electrolyte for Li-CFx batteries extends the specific capacity of the cell beyond the theoretical maximum of conventional Li-CFx batteries.

Significance and Impact

Primary lithium batteries are a vital component of implantable medical devices, wearable electronics and military applications.

Research Details

- Li_3PS_4 (LPS) promotes the discharge of CF_x cathode with excellent interfacial kinetics. A tandem discharge of CF_x and LPS was enabled by LiF from the discharge of CF_x. The observed capacity of the novel solid cell is higher than the theoretical maximum of conventional Li-CF_x cells.
- The application of a solid electrolyte has resulted in a new non-solvated electrochemical pathway for the Li-CF_x system, thereby avoiding the volume expansion and heat generation issues of current generation devices.

E. Rangasamy, J. Li, G. Sahu, N. J. Dudney, and C. Liang, *J. Amer. Chem. Soc,* **DOI : 10.1021/ja5026358**

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Narrative Highlight Text: An innovative design of bi-functional electrolyte defies the theoretical maximum of conventional lithium carbon fluoride (Li-CF_x) batteries. This novel design enables the creation of long lasting batteries applicable in implantable medical devices, wearable electronics and military components. The discharge of CF_x cathodes results in the formation of LiF that converts the solid electrolyte of Li_3PS_4 (LPS) as an electrochemical active component. This electrochemical activity is localized at the cathode, while the electrolyte remains stable at the anode. Such a selective stability enables a novel bi-functional electrolyte design.[1] The additional capacity offered by the electrolyte results in an observed capacity beyond the theoretical maximum for conventional Li-CF_x cells. Additionally, amorphous LiF is formed in a solid-state cell. This helps in the elimination of issues arising from solvents and crystalline LiF (volume expansion and heat generation) in conventional Li-CF_x cells. A homogenous dispersion of electrode, electrolyte and the current collector results in a 3D mixture delivering excellent performance at various discharge rates. The all-solid cell exhibits excellent stability and performance over a wide temperature range.

Reference

"Pushing the Theoretical Limit of Li-CFx Batteries: A Tale of Bi-functional Electrolyte"
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