

## Potassium-ion Battery Technologies

A **potassium-ion battery** is a type of battery and analogue to lithium-ion batteries, using potassium ions for charge transfer instead of lithium ions, which was first introduced by the Iranian/American chemist Ali Eftekhari (President of the American Nano Society) based on a potassium compound Prussian blue as the cathode material.<sup>[1]</sup> The reason for this selection was high electrochemical stability of Prussian blue,<sup>[2]</sup> and thus the prototype of the battery was successfully used for millions of cycles.

The potassium battery has certain advantages in comparison with similar lithium batteries (e.g., lithium-ion batteries): the cell design is simple, and both the material used and the procedure needed for the cell fabrication are cheaper. The prototype was made of KBF<sub>4</sub> electrolyte though almost all common electrolyte salts of lithium batteries (their potassium salts) can be used for the construction of potassium battery. The chemical diffusion coefficient of K<sup>+</sup> in the cell is higher than that of Li<sup>+</sup> in lithium batteries, which is due to a smaller Stokes radius of K<sup>+</sup> in electrolyte solution (solvated ions). Since the electrochemical potential of K<sup>+</sup> is identical to that of Li<sup>+</sup>, the cell potential is similar to that of lithium-ion. Potassium batteries can accept a wide range of cathode materials with excellent rechargeability, cheaper materials, etc. A noticeable advantage of potassium battery is the availability of potassium graphite, which is used as an anode material in current lithium-ion battery. Its stable structure guarantees a reversible intercalation/de-intercalation of potassium ions during the charging/discharging process.

In 2005, a potassium battery that uses molten electrolyte of KPF<sub>6</sub> was patented.<sup>[3][4]</sup> In 2007, a Chinese company Starsway Electronics marketed the first potassium battery-powered portable media player as a high-energy device.<sup>[5]</sup>

It is believed that potassium battery can replace lithium battery for large-scale energy storage because of its exceptional cycleability, as reported by the researchers of Northwestern University in Nature Communications.,<sup>[6][7]</sup>

The low cost of potassium in comparison with lithium has highlighted the idea of potassium battery in other forms too. Researchers at Ohio State University (OSU) have demonstrated the concept of a potassium-air (K-O<sub>2</sub>) battery with low over potential. Its charge/discharge potential gap of about 50 mV is the lowest one that has ever been reported in metal-oxygen batteries. Because of this it can provide an exceptional round-trip energy efficiency of >95%. In comparison, Li-O<sub>2</sub> batteries have a much higher over potential of 1–1.5 V, which results in a low round-trip efficiency of 60%.<sup>[8]</sup>

## References

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