

Ionic liquid mixtures as safe electrolyte for lithium-ion batteries

There is an intense drive in the present scenario towards the efficient generation and storage of energy for carrying out the various power driven mechanics of life. The energy demand for development and sustenance of the world is mainly driven by the exhaustive non-renewable energy reserves like coal and petroleum. But at present batteries have come to support the energy requirements by storing energy as chemical energy and continuously supplying electrical energy. This generation of electrical energy from battery is not exhaustive as the discharged battery can be recharged again by reversing the chemical reactions and this process of charge-discharge lasts for several thousand times. Thereby they support a range of applications starting from a hand-held gadget, portable electronics, to Laptops, hybrid vehicles, powering industrial machines, and aviation products as they are cheap, easy to fabricate and maintain as well as safe.



Fig. 1.

Lithium-ion batteries are the member of rechargeable batteries, which has the unique ability of possessing highest energy density. At present day-to-day life Li-ion batteries have attracted attention due to their capability of holding and providing a large amount of charge per unit of the Li-ions involved. They have grown in popularity rapidly so much so that they drive maximum gadgets utilized by the modern man. But there is also an associated loop hole, which is the instability of Li-ions at high operation potentials with the electrolyte present in the battery. A battery is essentially composed of three basic components viz., anode, cathode and an intermediate electrolyte. Li-ion batteries consists of Li-ions dissolved in organic media as electrolytes (organic carbonates like ethylene carbonate, propylene carbonate and alike). These electrolytes are having a central role towards the healthy functioning of the battery as during discharging (or providing power) they supply Li-ions to the cathode but while storing charge i.e. during charging they shuttle Li-ions to the anode. The friction associated with this shuttling sometimes leads to serious blasts of these batteries, as the organic electrolytes have a high tendency to catch fire. This is a grave concern and requires great attention from the scientific community.

This crucial situation motivated us to work towards the development of an alternate electrolyte which is highly stable and still provides the same conductivity and activity as an organic electrolytes but at negligible risk. Two novel Ionic liquids (ether-ether and ether-siloxane moiety containing imidazolium cation and a large bis(trifluoromethanesulfonyl)imide anion) were presented in our research which act as electrolytes mixture with an addition of minimal amount of organic media (propylene carbonate). The key aspect of these ionic liquids is their ability to dissolve Li-ions and transport them efficiently to and fro between the cathode and anode with a complete elimination of the risk of fire. They do not react even with the electrode components and maintain the stability of the entire battery system. This feature has been shown in our work by performing numerous charge-discharge cycles under operational battery conditions. Besides their activity, preparation of these IL-electrolytes are simple, can be scaled-up to the industry level and is also eco-friendly as the reaction is performed in microwave at a very short time scale.

Conclusively, this study brings forward an advancement in the development of today's most prevalent energy storage device, the battery. This newly synthesized ionic liquid along with a minute amount of organic substituent is cost effective and stable alternative to the routine organic electrolytes which suffered a risk of instability. This is a small step towards a safe battery in the hands of mankind.

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