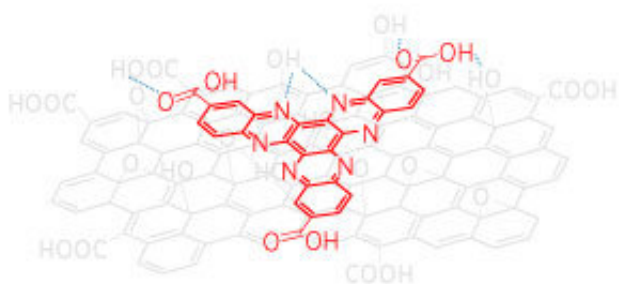


Cathode material made from organic molecules enhances the green credentials of rechargeable batteries

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active organic molecule HATNTA (red) to a graphene oxide support (grey).
Credit: The Royal Society of Chemistry

Incorporating organic materials into lithium ion batteries could lower their cost and make them more environmentally friendly, A*STAR researchers have found. The team has developed an organic-based battery cathode that has significantly improved electrochemical performance compared to previous organic cathode materials. Crucially, the new material is also robust, remaining stable over thousands of battery charge/discharge cycles.

The [cathode](#), the positive electrode in Li-ion batteries, is a critical component. An electron-deficient, rigid organic molecule called hexaazatrinaphthalene (HATN) was previously investigated as an organic

cathode material for lithium ion batteries. However, its promising initial [performance](#) declined rapidly during use, because the molecule began to dissolve into the battery's liquid electrolyte.

A new cathode material, in which HATN was combined with graphene [oxide](#) in a bid to prevent the organic material from dissolving, has now been developed by Yugen Zhang and his colleagues from the A*STAR Institute of Bioengineering and Nanotechnology.

In graphene oxide, a single-atom thick sheet of carbon atoms is partly covered by a layer of oxygen atoms. "Graphene oxide has excellent electronic conductivity, and surface oxygen functionality that may form hydrogen-bonding interactions with HATN," Zhang says. He explains that this made graphene oxide a promising candidate for forming a HATN-graphene oxide nanocomposite.

The nanocomposite's performance exceeded expectations. The [materials](#) combined to form core-shell nanorods in which the HATN was coated with graphene oxide. "Graphene oxide and HATN formed a very nice composite structure, which solved the dissolution issue of HATN in electrolyte and gave the cathode very good cycling stability," Zhang says. A [lithium ion battery](#) using this material as its cathode retained 80 per cent of its capacity after 2000 charge/discharge cycles.

The team saw even better performance when they combined graphene oxide with a HATN derivate called hexaazatrinaphthalene tricarboxylic acid (HATNTA). A battery made from this material retained 86 per cent of its capacity after 2,000 charge/discharge cycles. The improved performance is probably due to the polar carboxylic acid groups on the HATNTA molecule, which attached the molecule even more strongly to the [graphene](#) oxide.

The team is continuing to develop new materials to improve the

performance of organic cathodes, Zhang says. Aside from investigating alternatives to [graphene oxide](#), the team also is working on HATN-based porous polymers for use as organic cathode materials, which should enhance the flow of ions during battery charge and discharge.

More information: Jinquan Wang et al. Hexaazatriphenylene derivatives/GO composites as organic cathodes for lithium ion batteries, *Journal of Materials Chemistry A* (2018). [DOI: 10.1039/C7TA10232A](https://doi.org/10.1039/C7TA10232A)

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