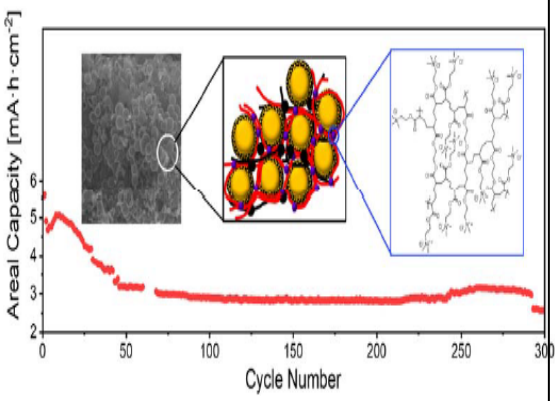
UNIVERSITY OF WATERLOO

TECHNOLOGY SUMMARY



Reference
10161

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Stage of development
Prototype build and ongoing development

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Multifunctional Cross-linked Binders for Lithium Sulfur or Lithium Sulfide Battery Cathodes

Background

The rising demands in advanced energy storage devices for electric vehicles, unmanned aerial vehicles and robots call for forward-looking battery technologies that can exceed the specific energy afforded by intercalation chemistry. An approach based on lithium-sulfur (Li-S) conversion chemistry is promising for next generation electrochemical batteries, due to sulfur's high theoretical specific capacity of 1675 mA·h·/g and energy density of 2800 W·h/L. The high natural abundance and innocuity of sulfur further contributes to the low cost and appeal of such a system.

The commercialization of Li-S batteries, however, has been plagued by low areal sulfur loading, poor sulfur utilization, and capacity degradation. These drawbacks originate from the dissolution and shuttling of lithium polysulfides, a large volume change in the cathode during cycling, and a lengthened electronic/ionic pathway in thick electrodes.

Description of the invention

One of the very challenging aspects of Li-S battery development is fabrication of a sulfur electrode with high areal loading using conventional Li-ion binders. This technology reports a multifunctional cross-linked polymeric binder that not only confines the soluble polysulfide species, but also has the desired mechanical properties to allow stable cycling of high-sulfur loading cathodes.

Advantages

The extensive crosslinkage enables this polymeric binder to exhibit a low degree of swelling, as well as high tensile and toughness moduli. These attributes are essential to maintain the architectural integrity of the sulfur cathode during extended cycling. Using this material, Li-S cells with high sulfur loading (6.0 mg·cm-2), and a low-intermediate electrolyte/sulfur ratio (7 µL:1 mg) achieve an areal capacity of 5.6 mAh.cm2, and can be (dis)charged for 300 cycles with stable reversible redox behavior after the initial cycles.

Potential applications

This technology shall be used as binders for Lithium Sulfur and Lithium Sulfide battery cathodes for following applications:

- Advanced energy storage devices.
- Energy storage for vehicles
- Energy storage for unmanned aerial vehicles and robots.