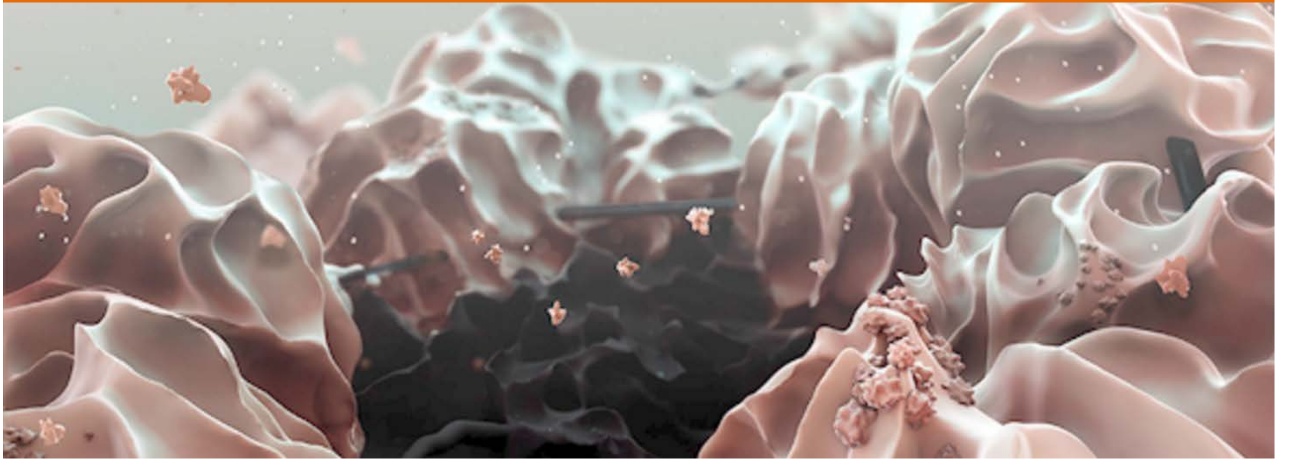
Highly Rechargeable & Efficient Li-Air Battery

Ground-breaking innovation for lithium batteries



Professor Clare Grey and her team at the Department of Chemistry have developed a novel technology for aprotic Li-Air batteries. This ground-breaking technology uses a spongy graphene cathode and new chemistry based on the formation of LiOH. The resulting battery exhibits extremely low over-potential (<0.2 V), leading to efficiency greater than 90% and fewer side-reactions. The battery can be charged and recharged for more than 1000 cycles. The battery is also stable with respect to moisture.

Key Benefits

- Tolerant to the presence of water
- Exhibits voltage hysteresis of only 200 mV, which sits comfortably in the stability window of graphene
- Cycles reversibly via formation of LiOH (not Li_2O_2)
- Exhibits a discharge/charge efficiency of over 90%
- Can be cycled at a capacity of 1000 mAh/g_c for more than 1000 cycles with zero capacity fading

Clare Grey, FRS, is Professor in the Department of Chemistry at the University of Cambridge. Her renowned contributions to research have led to numerous awards including the Günther Laukien prize in 2013 and the Davy Medal in 2014. Her team's work on Li-Air batteries is protected by a GB patent application and was published in Science.

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Why Lithium-Air batteries?

Li-air batteries can in principle deliver energy densities as high as 3450 Wh/kg (closer to gasoline than any other battery), but the technology has suffered from a large number of fundamental hurdles.

What problems does Prof Grey's new technology solve?

An exciting aspect of this technology is that it addresses several of the major hurdles of Li-air batteries.

The battery uses new cathode and electrolyte chemistries and has a different reaction mechanism at the electrode surface, which results in very low overpotential and therefore very high efficiency.

But in addition to the efficiency benefit, the low over-potential also enables the battery to operate with very few side-reactions – meaning the battery is stable over a large number of charge-discharge cycles.

Most notably, the present technology is tolerant in the presence of water. In addition, the high efficiency of >90% and ability to charge and recharge over 2,000 times are considerable breakthroughs.

How does it work?

The Li-Air battery utilises an electrode that is novel in terms of both material and structure: hierarchically porous reduced graphene oxide. A novel mediator (LiI) is also employed. Instead of lithium peroxide (Li_2O_2), as in most other Li-Air designs, the discharging reaction produces lithium hydroxide (LiOH) at the cathode.

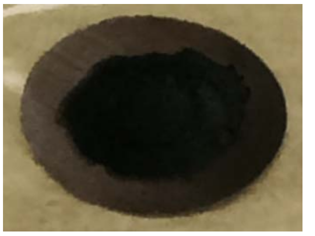
Further development work required

Further work is required in several areas, especially:

- Discharge rate (power)
- Dendrite formation
- Prevention of solvent evaporation / development of semi-permeable membrane
- Validation, upscaling and manufacturing

Next steps

Cambridge Enterprise (CE) is responsible for commercialising this technology, which is protected by a patent application that is likely to be extended into multiple territories. CE is now looking for partners to work with us and Prof Grey and her team, either in collaboration to address the issues above, or for commercialisation.



(a) Pristine

(b) Charged

(c) Discharged

Figure 1: Electrode topology and chemistry, restored after discharge

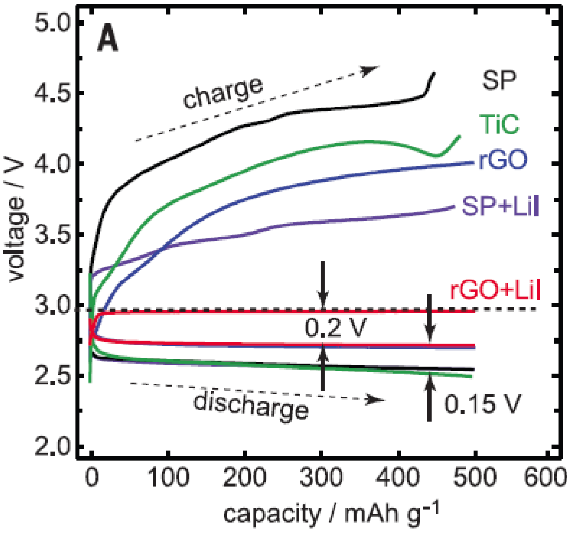


Figure 2: Electrochemical profiles of cells with different electrode/electrolyte combinations

Further information

Prof Grey's publication in Science can be found at:
http://www.sciencemag.org/content/350/6260/530.full

For collaborative or commercial discussions, please contact Julian Peck at Cambridge Enterprise.