**Seawater battery sparks sub dreams**

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Staying power for subs *(Image: OOIRCN Program/UW – Photo by Allison Fundis)*

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A REVOLUTIONARY battery that exploits the reaction between lithium metal and seawater could soon be powering everything from autonomous submarines to buoys and deep-water sensors.

Lithium is already widely used in batteries because it is lightweight and has a high electrochemical potential. This potential allows it to generate in excess of 3 volts compared with 2 volts for lead-acid batteries and 1.5 volts for zinc-carbon cells. Today's lithium batteries pack plenty of energy by weight: around 400 watt-hours per kilogram compared with 100 Wh/kg for alkaline batteries and 40 Wh/kg for lead-acid batteries.

Existing batteries have electrodes made of materials containing lithium ions, because lithium metal is very reactive - it is corrosive and bursts into flames on contact with water. Yet in theory, using the raw metal instead of lithium compounds could allow much better performance. [PolyPlus](http://www.polyplus.com/), a start-up company based in Berkeley, California, has worked out how to safely exploit this potential.

The company had been working on a lithium-sulphur battery, but found that the sulphur tended to react with the lithium and destroy the electrodes. "We came up with the idea of protecting the electrode with a membrane that would allow lithium ions to pass through it," says electrochemist Steve Visco, co- founder of PolyPlus.

Visco coated the lithium with a solid ceramic membrane that lets lithium ions pass through, but is impervious to liquids and gases. This solid electrolyte keeps the lithium chemically isolated but allows it to be electrochemically active.

Instead of using sulphur as the second electrode, Visco decided to test the protected lithium electrode in water. Sure enough, the lithium ions traversed the membrane, while electrons that passed round an external circuit reacted with the hydrogen and oxygen in the water, creating lithium hydroxide [(see diagram)](http://www.newscientist.com/articleimages/mg21428615.800/1-seawater-battery-sparks-sub-dreams.html).

With an interlayer between the ceramic membrane and the lithium to stop them reacting together, Visco has created a battery that stores a record-breaking 1300 Wh/kg.

[James Bellingham](http://www.mbari.org/staff/jgb/), chief technologist at the [Monterey Bay Aquarium Research Institute](http://www.mbari.org/) in Moss Landing, California, thinks the battery will bring "large performance improvements in underwater applications". It will let autonomous submarines operate for longer or carry more instruments. After evaluating prototypes, Bellingham has become an adviser to PolyPlus.

Visco expects to set up pilot production of his lithium-seawater batteries within 12 months and put them into commercial production a year after that. These batteries are single use only, but PolyPlus is also working on a lithium-air version that is rechargeable.

