Energy Quarterly

News and analysis on materials solutions to energy challenges

mrs.org/energy-quarterly

Inside:

"There's a lithium battery in your future" title image: Close up of a battery in a Nissan Leaf at the 2009 Tokyo Motor Show. Credit: H. Kashioka.

Little precious lithium?

Lithium is on everybody´s lips these days, due in part to the 2019 Nobel Prize in Chemistry awarded to our own EQ Board member M. Stanley Whittingham and co-recipients John B. Goodenough and Akira Yoshino for their research in breakthrough battery technology.

Lithium is the lightest metal and, like other alkaline elements, it is highly reactive. Thus, it occurs only in its oxidized form. Because of its many interesting properties—high electropositivity, low weight, relative stability—lithium is widely used in the production of polymers, as antidepressants, as a fusion fuel candidate, as flux in ceramics and glasses, and as a "rocking chair" intercalating ion in Li-ion batteries. Li-metal batteries, which would be even more effective, unfortunately are not reliable and safe enough to be applied broadly.

The transition from combustion-based to electric mobility in transportation raises the question of increasing demand and limitations of new material supply chains. Lithium might become a very critical element, although it is abundantly found even in oceans because of its water solubility. Geological lithium resources are not easy to quantify—the published data vary according to political whims—but are certainly abundant: at least 15 million metric tons of reserves are proven. Lithium extraction from brines and hard-rock mines, currently around 40,000–50,000 metric tons, will increase dramatically along with the price of battery-grade lithium salts. Better technologies will be required at the extraction sites to safely provide larger amounts of this future high demand material and, therefore, more and more precious raw material.

Until now, recycling lithium has not been an economical option. However, as the demand for raw material for millions of new Li-ion batteries increases—for the storage of electricity from newly installed renewable energy sources and for the huge number of new electric vehicles—the number of end-of-life batteries will pile up. The Li-ion battery industry will require efficient recycling, reuse, refurbishment, and electrode regeneration to limit the environmentally intense mining of lithium.

The regeneration of lithium-containing materials and effective extraction of lithium from ceramics, glass, ores, and e-waste by efficient delithiation, mechanochemical, soft hydrometallurgical, electrochemical, bioleaching, or solvothermal processes will avoid the deposition of lithium salts and prevent the increasing dissipation of lithium in the environment. Because lithium wastes are partly water-soluble and might be toxic or could interfere in other unforeseen ways with the biosphere, follow-up problems for human beings cannot be excluded.

Only intense materials research for an efficient circular economy and green chemistry recycling processes will guarantee a waste-neutral future as well as a smooth energy transition to prevent new waste-related problems, such as CO_2 dissipation-initiated climate change, for lithium.

Anke Weidenkaff

https://doi.org/10.1557/mrs.2019.296 Published online by Cambridge University Press