Waste lithium batteries pictures

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Just as humans can"t escape the aging process, neither can batteries. However, NREL researchers are hoping to find a way to recover materials from these batteries even after their useful life is considered over.

The ability to recover the critical materials from spent Li-ion batteries could be the key to making electric vehicles (EV) more affordable--and, in essence, the key to getting more EVs on the road.

Today, Li-ion batteries are the main power source for the multitude of portable electronics like smart phones, laptops, and tablets that consumers consistently use, in addition to power tools and other personal, commercial, industrial, and military applications that are only growing in demand.

It turns out that taking a closer look at Li-ion cells could be the key to mass adoption of Li-ion recycling in the United States. Unlike lead-acid batteries, which are recycled at a rate of 99%, Li-ion batteries are recycled at a rate of less than 5%. The recovery rate of the critical materials in Li-ion batteries is even less. One way that NREL is working to increase this recycling rate is by using an established imaging tool--electron backscatter diffraction (EBSD)--for an innovative purpose.

"EBSD via scanning electron microscopy (SEM) is an established technique," said Helio Moutinho, an NREL senior scientist who specializes in analytical microscopy. "But we at NREL are among the first to use it to analyze batteries at the microscopic level."

The Li-ion batteries used in today"s products exhibit a number of different chemistries, which poses a unique challenge to effective and economical recycling. This variation in initial chemistry is compounded by variation in the way the battery is used throughout its lifetime, leading to significant diversity in the structure and chemistry of Li-ion materials when they reach their end of life. Unlike lead acid batteries, there may not be an optimal, one-size-fits-all method for recycling Li-ion batteries.

Using EBSD, in conjunction with SEM and energy dispersive X-ray spectroscopy, NREL researchers can clearly identify the structure, chemistry variations, grain orientations, and crack formations happening in Li-ion batteries at the end of their useful life. The research is intended to bridge the gap between fundamental science research and industry and could eventually be a useful tool for industry on a production line.

"The hope is that our technique will turn into a sorting diagnostic tool for future lithium-ion battery recycling efforts," said Moutinho. "By taking a closer look, we could recommend different recycling methods based on what"s happening in each battery--and then repurpose the critical materials for a chance at a second useful life."

In the renewable energy technology space, considering the end-of-life effects is becoming an important

requirement to the viability of new renewable energy designs. More and more, researchers are emphasizing that the viability of new technologies be based on their potential to be recycled--and even upcycled.

The idea of designing to recycle is not new. It"s been around for decades. The circular economy framework is organized around the principles of designing out waste and repurposing waste for future use. By thinking about end-of-life issues up front, NREL researchers are working to reduce waste and mitigate critical material supply issues in the future.

"The battery manufacturing market for vehicles and stationary energy storage is growing," said Mann, transportation infrastructure analysis team in NREL"s Transportation and Hydrogen Systems Center. "Focusing on battery recycling could provide a competitive edge as it gives the U.S. reliable access to the raw materials needed for battery manufacturing."

The logistics of getting old Li-ion batteries safely out of people"s houses and EVs to recycling facilities still presents a major challenge, one that the U.S. Department of Energy (DOE) is hoping to tackle within a few years. DOE is awarding cash to innovators, entrepreneurs, businesses, researchers, universities, and scientists who propose the most promising solutions.