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AIT DEVELOPS METHOD FOR LITHIUM DETECTION

Researchers at the LKR Leichtmetallkompetenzzentrum Ranshofen have developed a method that significantly simplifies the detection of lithium in the context of battery and material development.

Ranshofen/Vienna (AIT): Many of the most important technological and social innovations of the 21st century would not have been possible without lithium-ion batteries: Since their market launch in 1991, these batteries have developed into a key technology for operating mobile devices, for all types of electric vehicles and increasingly for use in stationary energy storage systems due to their comparatively high energy density and service life. It was only consistent that the 2019 Nobel Prize in Chemistry was awarded to three lithium battery researchers. But lithium also plays an important role in other technological fields, such as super-light structural alloys for aerospace.

In the further development of lithium materials for the various applications, however, the researchers have faced one problem: Until now, there has been no simple method in practice for the spatially resolved determination of the lithium content at the microscopic level. This information is important in order to develop or further optimise materials with desired properties. In the case of lithium, researchers are, so to speak, groping in the dark.

Lithium is hard to detect

An electron microscope equipped with a detector for energy dispersive X-ray spectroscopy (EDS) is usually used to determine distribution profiles and maps of elements. While the electron beam scans the sample in nanometre steps, a chemical spectrum is recorded for each point, which provides information about the composition. From this, one can create pictorial representations of the element distribution, so-called maps.

The problem with lithium is that, as the lightest solid element (atomic number in the periodic table of the elements: 3), it cannot be identified with common EDS detectors. Although lithium atoms also emit characteristic X-rays when excited, these are so low-energy that they cannot be detected. Consequently, when creating an EDS map of a sample containing lithium, only the other elements are mapped, but lithium itself is "invisible". Although alternative methods for quantifying lithium have been proposed in the scientific literature, they require special equipment and are therefore very complex and expensive.

Combination of two measurement methods

A team led by Johannes Österreicher, Senior Scientist at the LKR Leichtmetallkompetenzzentrum Ranshofen of the AIT Austrian Institute of Technology, has now been able to circumvent these difficulties: They developed a new method for mapping lithium at the microscopic level that can be

carried out with a standard scanning electron microscope and does not require any additional exotic analytical equipment. The EDS method is combined with so-called quantitative backscatter electron microscopy (qBEI). Backscattered electrons are those electrons of the electron beam in an electron microscope that penetrate the sample, are deflected by the atomic nuclei and scattered back again. The backscattered electrons can be detected and are often used for imaging because areas of different chemical composition appear differently bright.

The AIT team made use of this effect: With the help of different element standards, a calibration of the brightness via the atomic number was created to determine the average atomic number of each point on a sample. Combining this information with a conventional EDS measurement, the lithium content for each point can be calculated – even for very small amounts of lithium. "Due to the huge importance of lithium-ion batteries, lithium has become the holy grail, so to speak, of spatially resolved chemical analysis in electron microscopes. With our new method, we have taken a decisive step forward," Johannes Österreicher is pleased to say.

Cooperation with US industry partner

An international patent application was filed for the new method and it was published in the renowned journal "Scripta Materialia". This immediately triggered lively interest from electron microscope manufacturers. Subsequently, AIT entered into a strategic cooperation with the company Gatan from California (USA) to further develop and market the method. Gatan is a leading company in electron microscopy and part of the AMETEK Group, which is almost twice as large as Austria's largest company, OMV, in terms of market capitalisation of almost 32 billion dollars. Initial joint work confirmed the potential of the new method, so much so that a joint poster has already been shown at the Microscopy&Microanalysis 2021 conference. "On Gatan side we are very excited to work together and we are looking forward to establish an expanded collaboration programme. Partnership with the AIT team is our ultimate privilege and an opportunity to support front line research," says Oleg Lourie, Director of Product Management/SEM at Gatan.

Valuable information for research & development at AIT

At the LKR, the new method for detecting lithium provides valuable services in the further development of high-performance materials such as magnesium-aluminium-lithium alloys, which are interesting for many applications in the mobility sector. The new measurement method is also very important for the work in AIT's Battery Lab, where lithium-ion batteries are optimised and solid-state batteries of the future are developed. "This new method helps us a lot in realising fundamental innovations for the next generation of sustainable transport technologies," explains Christian Chimani, Head of the AIT Center for Low-Emission Transport and Managing Director of the LKR.

Further Links

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