Application Brief

Materials Testing & Research

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Applications of FTIR Throughout the Lithium Ion Battery Life Cycle

Analysis of materials in the LIB value chain using an Agilent 4300 handheld FTIR spectrometer

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The role of FTIR in battery technology

Global demand for lithium ion battery (LIB) technology is increasing rapidly, driven by the need to reduce carbon emissions and mitigate climate change. The LIB value chain involves many critical elements and materials, many of which are IR-active and can be spectrally examined *in situ* using an Agilent 4300 handheld FTIR spectrometer. The 4300 can be used at each stage of the value chain, reducing costs and improving efficiency while providing spectral assurance of the material involved (Figure 1).

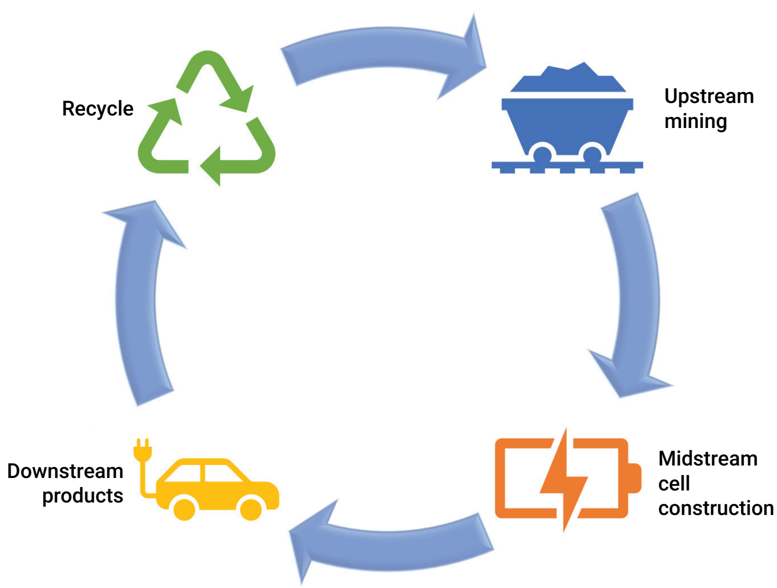

Figure 1. The LIB value chain: a summary of the processes involved in the production, distribution, use, and re-use of LIBs. The Agilent 4300 handheld FTIR spectrometer can be used at each stage of the value chain.

The 4300 handheld FTIR has the widest selection of interfaces of any portable FTIR, including two internal reflection interfaces (diamond ATR and germanium ATR), based on attenuated total reflectance geometry, and three external reflectance sampling interfaces: specular reflectance, grazing angle, and diffuse reflectance. The latter is a direct sample preparation-free diffuse technique and is also force-free. In addition, the last interface type is transmission. All six interfaces are shown in Figure 2.

Figure 2. Agilent 4300 handheld FTIR spectrometer and range of interchangeable sampling interfaces.

4300 FTIR LIB-related applications

Upstream, the 4300 handheld FTIR spectrometer can be used for raw materials testing and qualification including:

- Lithium material identification
- Ore minerals
- Rare earth element (REE) ores
- Extraction and refining to intermediate or end-use forms
- Petrochemicals

Midstream, the applications that can be covered include:

- Cathodes (lithium-based inorganic binder, conductive additives)
- Electrolyte analysis
- Separator analysis (olefin polymer, ceramic and polymer, etc.)
- Anodes (composition, additives, binder)
- Housing
- Modulation (combining batteries and electronics into end-use format)
- Current collectors (cleanliness/oxide level)
- Elastomers, spacers, and gap fillers

Downstream, incorporation into end-market products:

- Electric vehicle (EV) batteries
- Energy storage
- Consumer electronics
- Aerospace and satellite
- Medical and power tools

Recycle and recovery:

- Mineral recovery
- Plastic separation

Proven capabilities of the 4300 FTIR across the LIB life cycle

The 4300 FTIR has been used extensively across the LIB life cycle. The technique can easily be applied to the identification (ID) of the chemical structure of the LIB separator (thin films typically of plastic). Separators are inert and passive materials that are prime for recovery and recycling. Less obviously, 4300 FTIR applications relate to the anode, including: lithium iron phosphate (LFP), lithium cobalt oxide (LCO), lithium manganese oxide (LMO), lithium nickel manganese cobalt oxide (NMC), and lithium titanium oxide (LTO), plus any binders and/or additives.

Despite the diversity of materials in the LIB value chain, all of these compounds are FTIR-active and can be measured directly and non-destructively using the 4300 FTIR and any one or more of the interfaces.

The 4300 FTIR has also been used for other LIB-related applications including the ID of minerals to inform the refining process, electrolyte component composition checks for quality assurance of the electrolyte formulation, and polymer ID. It also plays an important role in the research and development of new materials and additives, and ageing studies.

Fast, direct, nondestructive testing

The Agilent 4300 handheld FTIR spectrometer can measure and identify a range of inorganic minerals, materials, and mixtures, providing valuable information to enhance the design, production, and performance of LIBs.

The usability features and choice of sampling interfaces provide non-destructive analysis in the LIB supply chain and development of new materials.

The system is fully portable and easy to use, providing a tool to save time and money, and easily overcome common analysis challenges associated with battery material samples.

Contact Agilent today for further information.

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DE08350613

Printed in the USA, August 16, 2023
5994-6651EN

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