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Application News

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Powder Property Analysis

Particle Size Distribution Measurement of Lithium-Ion Battery Materials

■ Introduction

The active materials in lithium-ion batteries (LiB) are commonly particulate materials that are bonded to electrodes with a binder. The size and purity of these powder materials can affect the performance and manufacturing conditions of the battery. For instance, smaller particles can achieve higher power density and can increase the viscosity of electrode slurries created during the coating process. The coating thickness and density must be carefully controlled to achieve the final desired battery properties, such as charge rate, capacity, and durability. For this reason, it is important to control and monitor particle size distributions of these active materials to enable the development of efficient and high-performance batteries.

Cathode active materials are typically made of lithiated metal oxides such as lithium cobalt oxide, lithium manganese oxide, and lithium iron phosphate. Anode materials are commonly high-purity graphite. Laser diffraction particle size analysis is an excellent technique for fast analysis of particles from several nanometers to several millimeters in diameter. In the analysis below, three common LiB active materials were analyzed using a Shimadzu SALD-2300 laser diffraction particle size analyzer with a simple liquid batch cell.

Figure 1: SALD-2300 Laser Diffraction Particle Size Analyzer
Wet Measurement System Dry Measurement System

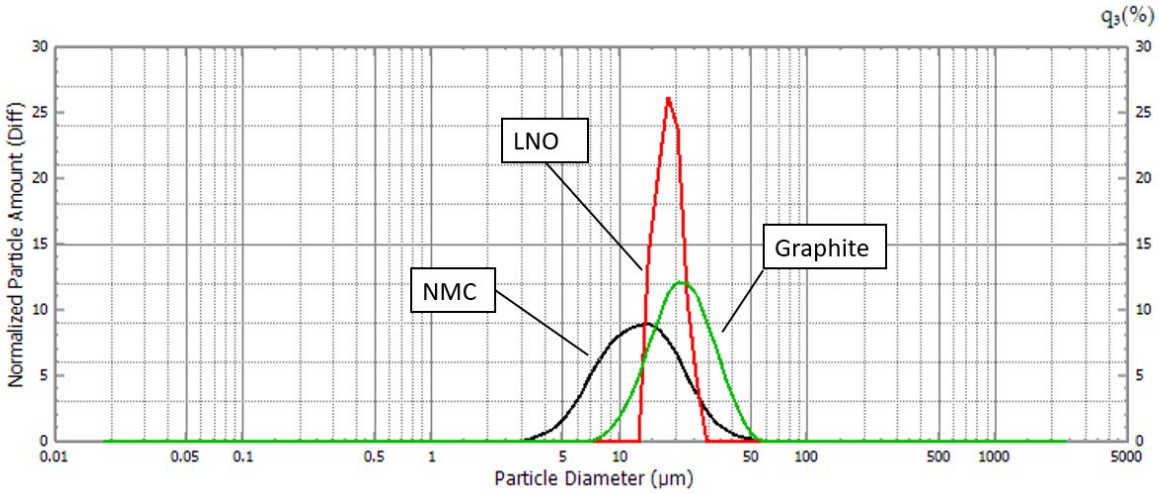
■ Test Samples and Results

Three commercially available LiB particle materials were analyzed: a lithium nickel-cobalt-manganese oxide (NMC), a lithium nickel oxide (LNO), and graphite. Measurement conditions are indicated in Table 1. The cathode materials were dispersed in water. The graphite showed low wetting (tended to clump together), so it was prepared in a water solution with Triton X-100 dispersant, a non-ionic surfactant. For each sample, a dispersion solution was prepared in a 50 mL beaker as the stock solution and sonicated. A portion of that solution was sampled, placed in a batch cell, and measured. Once loaded into the batch cell, the measurement took approximately 30 seconds. The measurement results are shown in Figure 2.

Table 1: Measurement Conditions (wet)

Dispersant	Purified water
Dispersing Agent	Triton X-100 (for graphite only)
Dispersing Method	Sonicated for 5 minutes in 100 W ultrasonic bath

The NMC had the smallest particle size, with a median diameter or approximately 12 microns. The LNO had median diameter of 18 microns, but had a much narrower distribution, with a D10 and D90 of 14 and 23 microns, respectively. The graphite had a median particle size of 21 microns. Results from laser diffraction are typically expressed as a volume distribution, meaning the particle amounts are normalized by the contribution each particle makes by volume. This makes the distribution more sensitive to large particles.



	Sample	Absorbance	Mean Value (µm)	10 %D (µm)	50 %D (µm) (Median)	90 %D (µm)
1	NMC	0.192	12.58	6.60	12.64	24.11
2	LNO	0.1	18.11	14.25	18.16	23.24
3	Graphite	0.089	21.00	12.78	21.11	34.04

Figure 2: Particle Size Distribution of Three LiB Materials

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