# Nickel-Based Cathode Materials for Lithium-Ion Batteries

## 1. Introduction

Lithium-ion batteries were first used in practical applications in the 1990s, and have now become an indispensable presence in everyday life as a power source for cellphones, notebook-type personal computers and other mobile devices. The battery capacity of the cylindrical 18650 type, which is mainly used as a power source for power tools, has increased from 1.0 h when first marketed to 3.0 h or more at present. This high capacity was achieved as a result of improvements in the cathode and anode materials, electrolyte, separator and other component parts. Realizing higher capacity cathode materials will be a key challenge for utilizing this type of lithium-ion battery as a power source for electric vehicles (EV) and energy storage systems (ESS), in which even higher capacities will be necessary.

Lithium cobalt oxide (LCO) and lithium nickel cobalt manganese oxide (NCM tertiary system) have mainly been used as cathode materials. However, in recent years, NCM with a higher compound ratio of Ni and lithium nickel cobalt aluminum (NC ) have attracted interest from the viewpoint of higher capacity.

s a major product that features high capacity, high safety and high cycling stability, JFE MINER L supplies the NC -based material 503LP to a wide range of fields, including electric power tools, vacuum cleaners and other power tools, digital cameras, unmanned aerial vehicles (drones), etc., contributing to high performance in those products. In order to respond to the need for even higher capacity of recent years, we are also devoting great effort to the development of a NC cathode material with a higher compound ratios of Ni.

## 2. Battery Performance of 503LP

**Figure 1** shows the charge and discharge properties of 503LP measured under a 25°C atmosphere using a simple battery cell assembled using metallic lithium (Li) in the counter electrode and 1M-$LiPF_6$/EC+DMC in the electrolyte. The charge property was measured under the conditions of 0.1 C and 4.3 V-CCCV, and the discharge property was measured under 0.1 C and 3.0 V cut-off. The discharge capacity was 188 m h/g, and charge-discharge efficiency was 89.2%. high capacity in comparison with LCO and NCM111 ($LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$), etc. is a distinctive feature of this product.

Table 1 Specification of prototype cell

| | | luminum laminated type |
|---|---|---|
| Cell | Packaging | |
| | Size | 124 × 72 × t2.3 mm |
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**Table 1** shows the specification of a protype laminated battery for evaluation of cycle performance, which represents cycle life performance, and safety. 503LP is used in the cathode, and general materials are used in the other components. Volumetric energy density is 370 Wh/L.

**Figure 2** shows the results of the cycle performance evaluation. Cycle performance was evaluated under the measurement conditions of voltages in the range of

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Table 3 Characteristics of high nickel-based cathode materials

| Item | | | 503LP | 721NT |
|---|---|---|---|---|
| Ni/Metal | | mol | 0.78 | 0.87 |
| Charge capacity | | mAh/g | 211 | 235 |
| Discharge capacity | | mAh/g | 188 | 210 |
| Efficiency | | % | 89.2 | 89.3 |
| Particle size distribution | D10 | μm | 8.8 | 9.3 |
| | D50 | μm | 13.5 | 14.2 |
| | D90 | μm | 19.4 | 20.0 |
| Compression density | | g/cm$^3$ | 3.55 | 3.55 |
| BET Specific surface area | | m$^2$/g | 0.55 | 0.47 |
| Alkali impurities | LiOH | % | 0.10 | 0.13 |
| | $Li_2CO_3$ | % | 0.03 | 0.11 |

4.25 V to 2.75 V and a 1 C current value under a 25°C environment. The discharge capacity of the new 721NT increased by 10% or more in comparison with the 503LP, and its charge/discharge efficiency and cycle performance were equal or superior to those of the 503LP. The evaluation results for other characteristics were also almost the same as the values for 503LP, as shown in **Table 3**.

## 4. Conclusion

JFE MINERAL has developed a new high-Ni cathode material product, 721NT, which features high capacity and high cycle performance, and is conducting sample work with the aim of early certification for use in high-grade power tools. We are also developing this product for EV applications, where there is a strong need for batteries that can increase the vehicle travel range per charge.

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