# Manufacturing Process of 46XX High-Capacity, High-Density Cylindrical-Type -Battery Cell Can

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**Abstract.** Among battery cells of various form factors, cylindrical-type battery cells are advantageous in mass production and relatively economical compared to other form factors. As the demand for higher storage capacity gradually increases, automobile manufacturers focus more on developing high-capacity and high-density batteries such as 46XX (where 46 means diameter and XX height ranging from 80 to 115). The energy capacity of the 46XX battery cells is over five times greater than that of the 1865 and 2170 cells. However, since no manufacturers were previously producing the 46XX, new issues were emerged in the process of manufacturing these new large-capacity cells. This research studies the manufacturing of the 46XX large-capacity cylindrical battery cell can through a multi-step forming process, utilizing finite element analysis. It also explores the industrial challenges encountered during the production of cylindrical battery cells and highlights the obstacles that need to be addressed for the widespread industrial application of the 46XX large-capacity cylindrical battery cell can.

**Keywords:** Cylindrical-type battery cells; 46XX; Manufacturing process; Finite element analysis.

## 1 Introduction

With the rapid advancement and increasing demand for electric vehicles (EVs), research related to EV technology has been actively conducted. Among the key components of an EV, the battery is considered the most critical, as it determines charging efficiency, energy density, and overall stability. These factors significantly influence the performance and reliability of electric vehicles. However, frequent reports of battery-related incidents, such as the EV fire that occurred in Incheon (Cheongna), Korea in August 2024, have highlighted safety concerns. Cylindrical batteries, which offer better fire safety, are gaining more attention compared to pouch-type batteries. Moreover, in the context of mass production and cost efficiency, cylindrical battery cells are preferred due to their simple structure, high stability, and efficiency

In particular, the 46xx cylindrical battery cell, developed and introduced by the American automaker Tesla, represents a next-generation innovation. Compared to the conventional 18650 and 21700 cells, the 46xx cell offers significantly improved energy density and capacity. Additionally, these batteries are not only used in electric vehicles but also applied in Energy Storage Systems (ESS), further expanding their industrial applications

## 2 Research Overview

In this study, a multi-step deep drawing process utilizing finite element analysis (FEA) was developed for nickel-plated steel sheets to secure high strength and corrosion resistance of 4680 battery cells while producing highly reliable can. To this end, mechanical tests were conducted to secure the material properties of nickel-plated steel sheets, and punch and die shapes for each process were designed and developed.

### 2.1 Materials

To determine the manufacturing conditions for first-generation battery can and establish the necessary basic material properties, a material property test was conducted using a uniaxial tensile testing machine. The test specimens were prepared according to ASTM E8 standards, specifically following the Subsize specifications. The tests were conducted in three different orientations: rolling direction (RD), diagonal direction (DD), and transverse direction (TD). A universal testing machine was used for the experiment. The test was performed with a 3D-DIC (Digital Image Correlation) system as shown in Fig.1. The tensile tests were performed at quasi-static strain-rate conditions with respective crosshead speeds of 1.5 mm/min. The measured results are shown in Fig. 2.

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**Fig. 1.** Uniaxial tensile test setup with 3D-DIC system

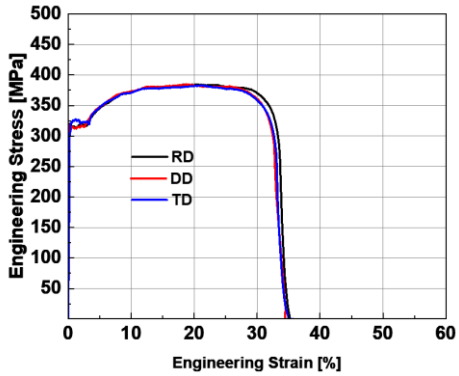


**Fig. 2.** Mechanical properties along the three different directions : rolling, diagonal, and transverse direction

### 2.2 Numerical Procedure and Simulation

A multi-step forming process was developed and simulated using Abaqus/Explicit to analyze material behavior, forming characteristics, and other relevant factors during the can forming. The appropriate material models were characterized not only the hardening law but also the yield function and flow rule. Fig. 3. shows one of the steps in the forming simulation of the 46XX high-capacity, high-density cylindrical battery cell can. To ensure computational efficiency while maintaining accuracy, a finer mesh was applied in high-deformation regions, while a coarser mesh was used in less critical areas to reduce computational cost. The boundary conditions included punch loading without any holding force, allowing unrestricted material flow during the forming process. The simulation results provided insights into the deformation mechanisms and stress distribution in the multi-step forming process. The absence of the holder contributed to a more natural material flow, closely resembling real-world forming conditions. Future studies will focus on optimizing process parameters and validating the numerical model through experimental comparison to further enhance its accuracy and reliability.

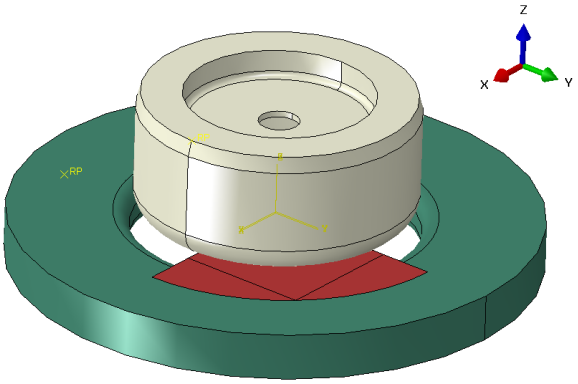


**Fig. 3.** Numerical simulation model for 46XX high-capacity, high-density cylindrical-type battery cell can

## 3 Conclusions

The development of 46XX large-capacity cylindrical battery cells presents significant advancements in energy storage, offering over five times the capacity of conventional 1865 and 2170 cells. However, the transition to mass production of these high-density cells introduces new manufacturing challenges that must be addressed. This study utilized finite element analysis to examine the multi-step forming process for producing the 46XX battery cell can, providing insights into key industrial challenges and production constraints. For the widespread industrial application of 46XX cylindrical battery cells, further research and process optimization are essential to overcome manufacturing complexities, material limitations, and production scalability issues. Addressing these challenges will enable more efficient mass production, ultimately supporting the growing demand for high-capacity energy storage solutions in the automotive and energy industries.

## Acknowledgments

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