

FROM MICRO TO MACRO: OPTIMIZING BATTERY DESIGN AND MANUFACTURING

Battery cell manufacturing is critical to the advancement of clean energy technologies, particularly in electric vehicles (EVs), renewable energy storage, and portable electronics. Altair offers a comprehensive suite of solutions to support the development of efficient and sustainable battery cells, from the microstructure of the raw electrode material to the battery cell life cycle.

Optimizing Battery Cell Efficiency

Efficient, high-quality battery production is essential for improving the performance, affordability, and accessibility of energy storage solutions. Rapid and effective battery cell development requires tools that can simulate battery components at the particle scale to predict and optimize the electrode microstructure. The physical testing of electrodes is time consuming, expensive, and requires a lot of special equipment. There are many process parameters that could ultimately affect the electrical performance of a battery cell; therefore, attaining appropriate values for the required final battery performance is challenging.

Altair's [battery design and simulation software](#) reduces prototyping and development costs while optimizing battery safety, performance, range, and efficiency. With [Altair® EDEM™](#), engineers can better understand the relationship between the electrode microstructure behavior and battery performance. This allows them to improve performance and efficiency by optimizing the electrode microstructure.

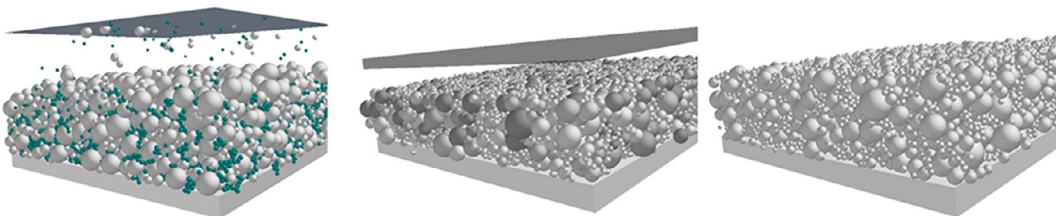


Figure 1 - EDEM simulation of the generation of NMC-particles and binder-conductive-matrix; electrode section before compaction; electrode section after compaction.



EDEM enables us to identify the optimum particle size distribution of active materials and increase the energy density for Li-ion Battery. By combining EDEM with AI tools, we can investigate particle behaviors under different conditions during the compaction process and speed up the development of next-generation active materials.

Dr. Yushik Hong,
computational structural
mechanics team leader,
LG Chem

Driving Battery Manufacturing Innovation

From battery manufacturing to multiphysics system optimization, Altair's battery design and simulation software provides a holistic approach to battery-powered solutions. With discrete element technology in EDEM, engineers can virtually test, predict, and optimize electrode microstructures and gain in-depth insights into the effects of material properties and manufacturing process conditions on battery behavior and performance. This enables users to virtually test ideas for the process and material conditions to help them find better solutions to improve the final result. Compared to traditional software, EDEM simulates the electrode material and most of manufacturing process steps, including mixing, coating, drying, and calendaring. EDEM uncovers the critical relationship between process parameters and material attributes with key performance indicators to optimize battery manufacturing. (Figure 2).

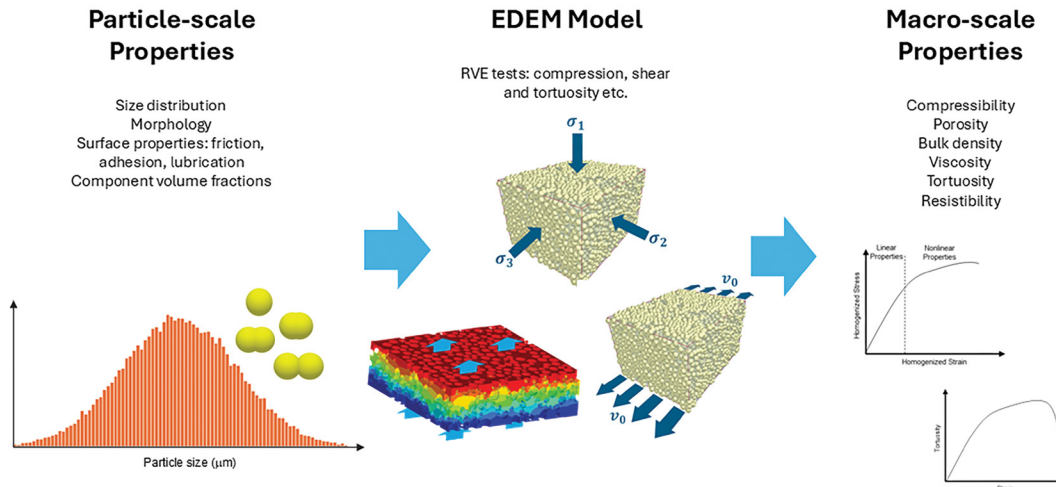


Figure 2 - EDEM's micro to macro approach to control the key performance indicators like tortuosity by controlling particle level properties like size distribution and shape.

Uncovering Insights With AI

Combining EDEM with additional optimization tools including [Altair® HyperStudy®](#) and [Altair® romAI™](#) is seamless thanks to Altair's flexible [Altair Units](#) licensing system. This value-driven approach empowers teams to explore a wide range of design possibilities, maximizing resources without being constrained by additional costs—something that would be prohibitively expensive with traditional licensing models. Engineers can quickly review a combination of microstructure compositions to review the effect on performance and determine what an optimal electrode configuration will look like. By integrating EDEM with AI tools, users can analyze particle behavior under various conditions during the compaction process. This approach accelerates the development of next-generation active materials.



We have used EDEM for various issues in the Li-ion battery development for many years. Thanks to the active support and professional skills of the EDEM technical team, I feel that the area of simulation that can be covered is expanding every year.

Dr. Sang-Pil Kim,
principal research engineer,
Samsung SDI

Sustainable Solutions

Battery manufacturers are under extreme pressure to maximize sustainability. By using EDEM, they can slash energy consumption and material waste by optimizing the manufacturing process with more sustainable solutions.

EDEM also helps foster a circular production life cycle when it's used to simulate and optimize the recovery of materials during battery recycling through processes like shredding, drying, sieving, and separation.

Visit altair.com/battery-design-and-simulation-software to learn how your organization can improve your battery cell design, manufacturing, and recycling processes.

