

Application Of COMSOL Multiphysics For Modelling And Simulation In Battery Design And Manufacturing

Kenneth Nwanoro¹

¹UK Battery Industrialisation Centre, Coventry, UK

Abstract

The application of modelling and simulation in lithium-ion battery and cell design and manufacture has been widely adopted in the cell manufacturing industry due to the several advantages and insights it provides. These advantages range from a faster time to market from the design concept, rapid prototyping and quick design change, design due diligence, and reduced cost of design, and prototype. In this presentation, we discuss the application of COMSOL Multiphysics to solving battery manufacturing challenges, including design iterations, process simulations and performance prediction and verification. The application of the COMSOL Multiphysics Geometry module for rapid cell structure and mechanical component design verification to the application of the COMSOL Battery design module for electrochemical simulation to predict cell and battery electrochemical performance will be presented. We present the workflow for using the COMSOL Multiphysics Heat Transfer and CFD modules for cell and battery thermal response prediction and cooling strategies for different real-world battery operating conditions. The application of the COMSOL Multiphysics Optimisation Module for battery and cell model parameter estimation ensures highly accurate cell and battery performance prediction for real-world applications. We further present the results of using COMSOL Multiphysics for predicting the impact of manufacturing defects, such as circular defects and pinholes, on cell performance, the impact of foreign particles from electrode processing on internal short circuit, and the effects of tab weld quality to predict localised heating and plating. Finally, we present the simulation (electrochemical, thermal and degradation) results compared with the actual test data of the state-of-the-art high energy cells developed at the UK Battery Industrialisation Centre (UKBIC) using COMSOL Multiphysics.

Figures used in the abstract

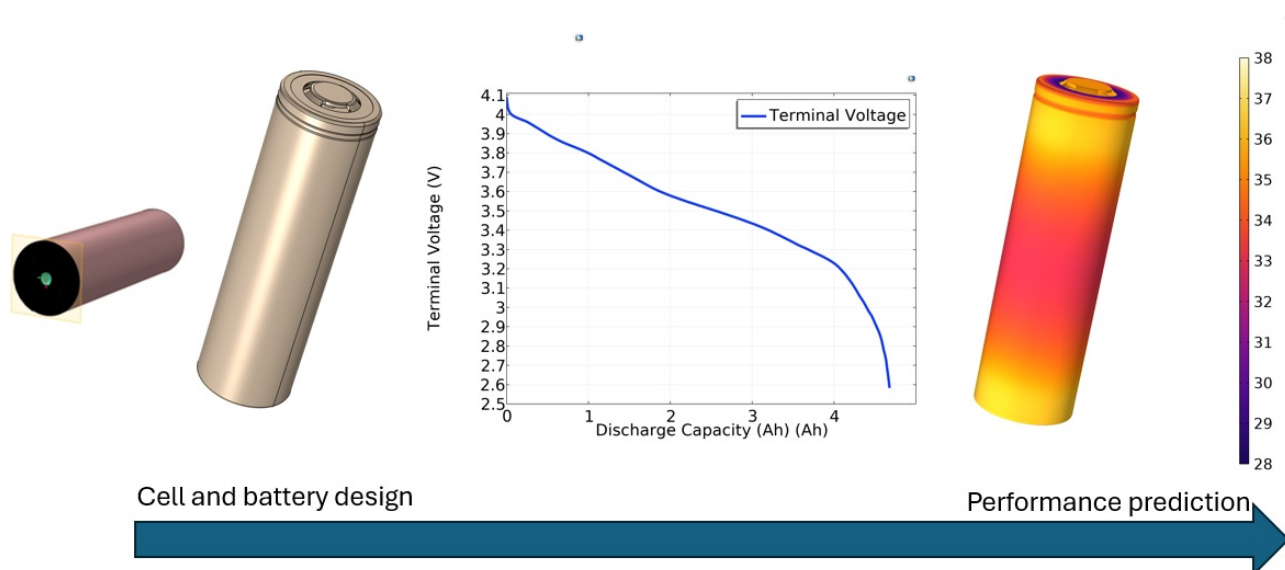


Figure 1 : Solving battery manufacturing and design challenges using COMSOL Multiphysics