T.C. Hacettepe Üniversitesi

Bilimsel Araştırma Projeleri Koordinasyon Birimi

Project Title	Modelling and Testing of Li-Ion Batteries for Normal Operating Conditions and for Temperature Dependent Failure Modes
Project Leader	Dr. Özgür Ekici
Researcher(s)	Dr. Murat Köksal
Project's Duration	24 months

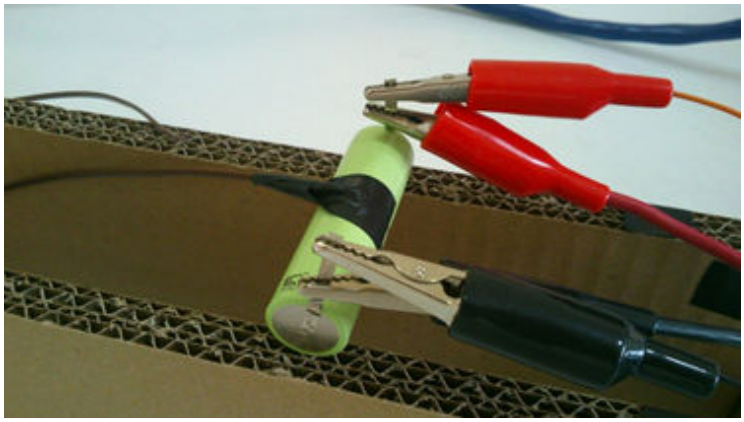
Energy storage systems and especially battery technologies are one of the leading research areas in our country as well as in the world. In this context, use of Li-Ion batteries in different area of utilizations and applications continues to increase recently due to the reasons such as the large energy density, long useful life and maintenance free operation of these systems. Comparing to the other battery technologies, Li-Ion batteries shine out as a convenient energy source for hybrid and electric cars because they can provide longer driving range, better acceleration and longer life-span. However, under the abnormal operating conditions, advantageous of having high energy density can also be the source of negative consequences such as thermal runaway, and for some conditions, fire, that constitutes a potential risk to be managed.

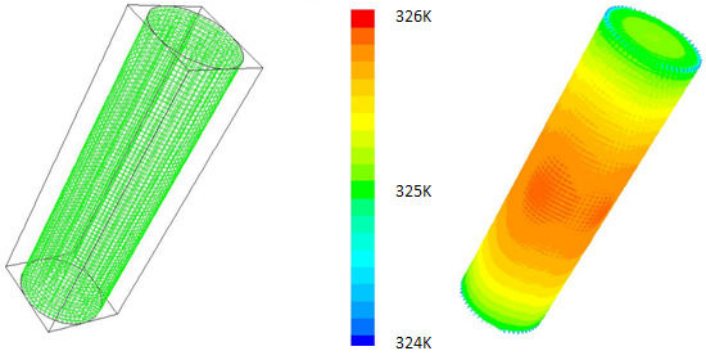
The aim of this project is to create a mathematical model of Li-Ion batteries that can be used in normal operating conditions and in failure modes. It is known that Li-Ion batteries show differences regarding their electrochemical properties, electrical characteristics and geometrical features. In this work 18650 cylindrical battery cell will be used which is the most widely used and one of the accepted cells as a standard. After creating a successful model, the method and the analyses conducted in the context of this work will be available to use for different types of battery cells. In depth knowledge of thermal characterization and safety predictions of Li-Ion batteries could be reached with the help of the model created in this work.

A mathematical model to be developed in this work will be based on simultaneous solution of heat and flow equations with differently detailed electrochemical reactions and the aim is to get results and publications in internationally recognized journals. Additionally, it is expected to have more pronounced widespread impact on national and international level because the mathematical model will be developed using open source, non-commercial solvers.

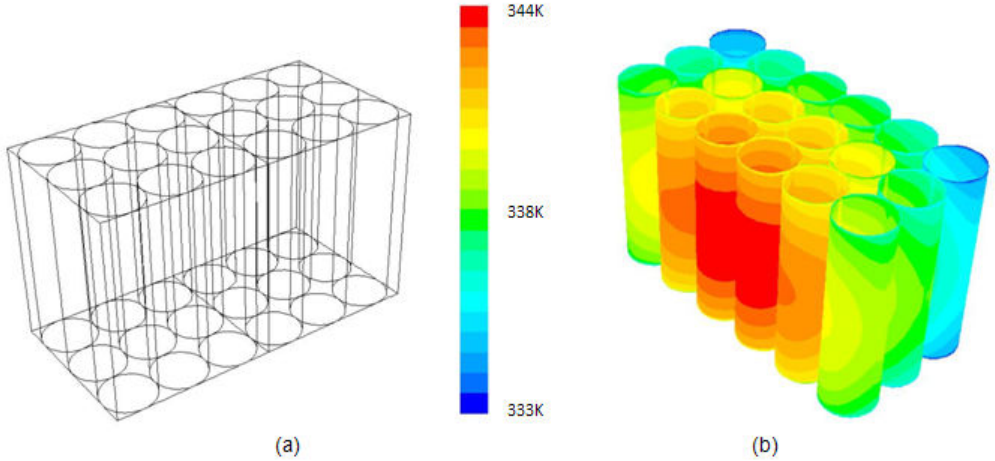
Keywords: Li-Ion batteries, thermal runaway, hybrid vehicles, electric vehicles, thermal management, numerical modeling.

A 18650 Li-Ion battery during a test:





A sample numerical solution: Geometric model of a battery cell and its protective cover (a), temperature distribution in a battery cell at the end of discharge (b)



A sample numerical solution: A sectional view from a symmetry axis of a system composed of 36 batteries, packed in 6x6 form (a), temperature distribution at the end of discharge (b)

A schematic of the relation between the mathematical model and experimental studies: