École Polytechnique Fédérale de Lausanne
Distributed Electrical Systems Laboratory
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Student project proposal

Project title
Internal temperature estimation of Li-ion cells

Project type ☒ MSc thesis ☐ BA semester project ☐ MSc semester project

Project responsible and e-mail
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Project description
Battery pack fires are starting to become a problem, especially in the transportation domain. To push for the adoption of EVs, it is paramount that they be made safe. Regulations stipulate that the driver of the EV must be informed of a battery fire at least 5 minutes in advance, so that the passengers can evacuate safely. The goal of the project is to develop a thermal model for a cell, which can enable the prediction of the time left until thermal runaway. Battery pack fires are starting to become a problem, especially in the transportation domain. To push for the adoption of EVs, it is paramount that they be made safe. Regulations stipulate that the driver of the EV must be informed of a battery fire (also known as a thermal runaway incident) at least 5 minutes in advance, so that the passengers can evacuate safely. This warning can be issued by accurate internal temperature estimation of the cells. There are various internal temperature estimation methods, and one of the most practically implementable is electrochemical impedance spectroscopy (EIS) -based temperature sensing. It has been found that using EIS, the internal temperature of a new cell can be determined. However, cells become more dangerous as they age, and hence, temperature sensing becomes even more critical for aged cells. The goal of the thesis is to validate if the EIS-based temperature sensing method can be used in aged cells.

Note: The project is in association with CSEM S.A., a research organization in Neuchâtel. The student will have to work on the CSEM premises for the project.

Tasks of the student
- Literature review on how thermal runaway occurs in cells and the different ways in which it can be modelled.
- Learn about various aspects of the EIS technique.
- Perform temperature measurement and analysis on aged cells.
- Build algorithm to estimate the time left until thermal runaway occurs.

Requirements
- Basics of thermodynamics and heat transfer
- Python programming
- Willingness to learn about batteries

Literature
[1] Feng, Xuning, et al. "Thermal runaway mechanism of lithium ion battery for electric vehicles: A review." *Energy storage materials* 10 (2018): 246-267.

[2] Wang, Zhenpo, et al. "Overcharge-to-thermal-runaway behavior and safety assessment of commercial lithium-ion cells with different cathode materials: A comparison study." *Journal of Energy Chemistry* 55 (2021): 484-498.

[3] Srinivasan, Rengaswamy, et al. "Instantaneous measurement of the internal temperature in lithium-ion rechargeable cells." *Electrochimica Acta* 56.17 (2011): 6198-6204.