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DOCTOR OF ENGINEERING SCIENCES

of **Md Sazzad Hosen**

The public defense will take place on **Thursday, 14th October 2021 at 4:00pm** in room D.2.01 (Building D, Brussels, Humanities, Sciences & Engineering Campus)

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ADVANCED LIFETIME MODELING OF LI-ION BATTERIES

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Abstract of the PhD research

Towards achieving sustainable green mobility, electrifying the vehicles is the most critical challenge. Moreover, being the heart of the electric vehicle (EV), the energy storage system needs to satisfy the end-users fulfilling the demanding requirements. The state of the art and still the preferred battery technology relies on the available Lithium-ion chemistries which are empowering the e-mobility for decades. However, the key battery issues are always addressed to keep pace with the ever-increasing demand and are also associated with battery development. The lifetime of the Li-ion batteries (LiBs) is the major aspect among all in large-scale adoption of EVs. Understanding the battery aging mechanism and the performance modeling would facilitate knowledge development and predict the first life of the batteries, respectively.

In this doctoral research, commercial Li-ion batteries of the two most common technologies are investigated thoroughly to develop lifetime models with high precision. The studied batteries are of different sizes and shapes consisting Nickel-Manganese-Cobalt Oxide (NMC) in the cathode and Graphite or Lithium Titanate Oxide (LTO) in the anode. More than 218 battery cells are investigated as part of several schemes with wide ranges of cycle life and calendar life (or relaxation) profiles. The schemes are designed to study different aspects of aging either in terms of capacity fade and/or internal resistance growth. The developed knowledge through this extensive research has helped to identify the sensitive aging parameters for the investigated cells that contribute to the battery degradation. The analyzed information has also shed light on the non-identical impacts of different aging and characterization parameters.

The established findings are utilized to develop several lifetime models and coupled models that could accurately predict the lifetime considering all the crucial aging aspects. The real-life worldwide harmonized light-duty test cycle (WLTC) is utilized to validate all the developed models. The established models have showcased high model accuracy with an root-mean-squared error score of 0.01 could be achieved with the best model. Hence, the developed models have different performance characteristics that are compared for a specific high-quality dataset. It is found that the neural network model performs best when compared with other methodologies. Moreover, to identify the associated aging mechanisms, a dynamically aged cell is opened under a safe environment to analyze the aged materials.