

PhD in Energetics

Research Title:

Calendar, cycling and fast recharging aging: experimental analysis of mechanisms, and inclusions in the battery models

| | |
|------------------|------------|
| Funded by | SILK - FAW |
|------------------|------------|

| | |
|-------------------|---|
| Supervisor | Roberto Fedeli (SILK - FAW) – Prof. Massimo Santarelli (POLITO) |
|-------------------|---|

| | |
|----------------|---|
| Contact | Prof. Massimo Santarelli – Prof.ssa Silvia Bodoardo |
|----------------|---|

| | |
|---|--|
| Context of the research activity | <p>July 14 2021: “Fit for 55”, meaning 55% reduction of CO₂ emissions by 2030, 100% by 2035 in EU. From now, in order to reduce air pollution and greenhouse gas emissions, battery electric vehicles (BEV) are in the center of the energy transition.</p> <p>The research is now focused on high energy density lithium-ion batteries, suitable for automotive sector.</p> <p>Different chemistries can be considered, from high capacity cathode (e.g. Ni_{0.6}Mn_{0.6}Co_{0.2}O₂) or more robust cathodes (e.g. LFP), different types of anode (graphite, one of the most common carbonaceous anode material, or lithium metal, for the lowest redox potential of -3.040 V vs standard hydrogen electrode and its considerable capacity of 3860 mAh g⁻¹).</p> |
|---|--|

| | |
|-------------------|---|
| Objectives | <ul style="list-style-type: none">• Study the aging mechanisms: fundamental mechanisms determining aging in conditions of calendar, cycling and fast recharging• Experimental campaign based on electrochemical impedance spectroscopy (EIS): the aging mechanisms will be analysed with reference to temperature, state of charge, deep of discharge (in case of cycle aging), time, which are the four characteristic variables affecting aging mechanisms. Impedance spectra and capacity fade will be analyzed and evaluated.• Modeling of aging: the aging mechanisms analysed by EIS will be translated in modeling mechanisms and included in the traditional multi-physics models of the batteries, to take into account aging phenomena |
|-------------------|---|

| | |
|--|--|
| | in the design phase, but especially in the control of the real time operation of the battery in a powertrain |
|--|--|

- | | |
|--|---|
| Skills and competencies for the development of the activity | <ul style="list-style-type: none">• Deep knowledge and understanding of the multi-physics processes governing the operation of a closed battery• Skills on electrochemical impedance spectroscopy analysis of closed batteries• Skills of development of multi-physics models, to include EIS analysis in aging models of the battery |
|--|---|