Today, more than ever, rechargeable batteries are silent companions in our day-to-day lives serving as energy storage units in all sorts of devices. The general characteristics and performance of batteries are the result of many factors and choices made during their design, such as: selection of appropriate materials, cell design, packaging design and charging strategy, which will ultimately affect the performance of the battery during its operation. Lithium-ion batteries, despite their tremendous commercial success, still struggle with incidents related to their stability and safety. The problem of their optimization and quality improvement is extremely complex. While problems related to strictly construction (macroscopic) aspects, such as the preparation of the electrode layer, pressing, cell assembly, electrolyte selection and forming, are relatively easy to capture and eliminate in the production process, electrochemical processes and associated complex crystallographic and morphological changes are not so easy to recognize. Some of the most precise and reliable research methods for monitoring materials are *in situ* (testing the material while working in the device) and *ex situ* (testing materials after using it in the battery) methods, thanks to which it is possible to observe even the smallest structural changes of the charging and discharging processes in the electrochemical cell.

Additionally, the substantial migration from fossil fuel powered to electric devices enforces the availability of capable batteries. Thus, this proposal concerning the development of an innovative analytical procedure to solve the problem of the detailed description of electrode processes and material stability in a lithium-ion battery in order to determine its optimal operating parameters and safe usage agrees with the EU Green Deal,[26] and a long-term research initiative of EU Battery2030+, where the goal is to demonstrate 5-10-fold improvement in materials discovery. Considering battery designs one should consider that in a long-term perspective lots of those complex materials have to be recycled, so stability and durable safe operation of the future batteries should be of a key importance in terms of economic significance or risk supply.

The main aim of the project is a combination of *in situ* and *ex situ* examinations in term of structural and morphological analysis and electrochemical testing for creating a precise description of electrode materials to find their stability parameters for safe battery operation. This research will lead to the development of a novel analytical procedure that could be applied in the battery "health" diagnostics through a rapid *in situ* Raman method inside the cell. The project results will give opportunity to find long-awaited answers to challenging questions on next lithium-ion batteries. This research will provide fundamental, but typically overlooked, answers alongside popular fast-paced research for the best performing battery.