As our world develops and becomes increasingly dependent on technology, it is crucial to find efficient and sustainable ways of storing energy. Traditional lithium-ion batteries are commonly used, but they face certain limitations due to the scarcity and high cost of lithium. Therefore, scientists are turning their attention to alternative battery technologies, such as sodium-ion batteries (SIBs), which promise a more accessible and environmentally friendly energy storage solution.

Therefore, a main goal of the project is to explore the potential of a group of materials called transition metal dichalcogenides (TMDs) as anodes in SIBs and understand the underlying mechanisms that govern their energy storage capabilities. Currently, the development of high-performance anode materials for SIBs faces challenges such as low capacity, poor cycling stability, and slow diffusion of sodium ions. By investigating TMDs beyond the well-studied material: MoS_2, the project aims to discover novel materials with improved electrochemical performance.

The research will involve synthesizing different TMDs using a solvothermal/hydrothermal method and carefully studying the effects of various synthesis parameters on their chemical and structural properties. By fine-tuning these parameters, it is assumed that the materials' electrochemical activity can be enhanced, ultimately tailoring them for better energy storage performance.

To gain deeper insights into the charge storage mechanisms and processes occurring within the TMDs during battery operation, an advanced technique called *in-situ* Raman spectroscopy will be employed. This technique enables real-time monitoring of structural and chemical changes in the TMDs while the battery is charging and discharging. By observing these changes, valuable information about the materials' performance will be uncovered, but also about the degradation mechanisms that can limit battery lifespan could be understood.

The research aims to address the research hypotheses regarding TMDs as anode materials for SIBs:

1. How do the structural and chemical properties of TMDs affect their performance as anodes in sodium-ion batteries?
2. What are the underlying mechanisms governing the storage behavior of sodium ions in TMDs?

By successfully answering these questions, it is assumed to optimize the design and interface properties of TMD-based anode materials. Through a combination of material synthesis, careful optimization, and cutting-edge *in-situ* Raman spectroscopy technique, this research project represents a step forward in the quest for better energy storage solutions. This optimization could lead to significant improvements in the performance, stability and lifespan of sodium-ion batteries, bringing us closer to a sustainable and efficient energy storage technologies. At the same time, it paves the way for a more environmentally friendly future, powered by advanced energy storage systems.