Abstract for the general public in English

With growing standards of living and increasing digitization of everyday life the global energy demands are also on rise. Re-chargeable Li-ion batteries are at the core of what powers the present-day internet of things (IoT) smart devices. Scientific research to develop new energy storage materials with higher energy storage capacities and safer for the environment is one of fundamental approaches to address this growing need of the human society. The current research efforts in the field of energy storage materials clearly show the impending progression towards all-solid-state batteries (ASSBs) as the most likely next generation rechargeable batteries technology.

Research in new anode materials for ASSBs has gained impetus after the recent discovery of a new class of 2D materials known as MXenes in 2011. They are found to possess interesting chemical, electronic, superconducting, magnetic and optical properties.

The main scientific goal of this project is to study experimentally in situ (in real-time) the structure evolution in 2D TMCs (MXenes) during lithiation and de-lithiation when they are used as anode in an all-solid-state Li-ion battery. The further purpose of this study is to gain fundamental insight into the atomistic structural factors in these materials that are responsible for limiting their Li-ion loading capacity.

Within the scope of achieving this goal we aim to develop CVD method for controlled growth of Mo_2C, Ti_2C, V_2C and Cr_2C MXenes (except Mo_2C, 2D structures of these other compounds are not yet successfully grown by CVD) and study the CVD growth process of the MXenes in order to use them for the solid state batteries, which are chemically safer, compact, faster re-charging and operable at higher temperatures compared to currently used Li-ion rechargeable batteries.

This project will be realized through scientific collaboration between research groups from Poland ŁUKASIEWICZ Research Network – PORT Polish Center for Technology Development, Wroclaw, and Norway University of Oslo and SINTEF. The partners will conduct together in situ experiments to simulate real life battery conditions inside aberration-corrected Scanning/Transmission electron microscopes to discover the physical matter and probing analytically their chemical nature. Such atomic level understanding of the processes will enable to inform for better design and development these materials to fully harness their Li-ion loading capacities.

The successful realization of this project will lead to the future proof of concept based on the new design of 2D structure devices for energy storage.