The current knowledge about the catalyst solid surface accepts that it is dynamic especially taking into account oxide catalysts. The researchers consider the surface as a ‘‘living’’ or ‘‘breathing’’ moiety under catalytic reaction conditions (changing the temperature, pressure, etc.). One of them – Tamaru – wrote more than 35 years ago that: “Catalysis is a dynamic process. Without studying the dynamic behavior of catalyst surfaces, no real nature of catalysts can be elucidated”. This statement is true even till now.

Presented project meets the most sophisticated expectation on developing a new methodology that will enable observation of the wealth of the surface structure and its overall nature engaging modern *in situ* and *operando* spectroscopy methods (Raman, IR, UV-Vis) and their combination with microscopic techniques. Thus, spectroscopy ideally measurements should be performed under realistic catalytic conditions. *In situ* refers to any spectroscopic result that is relevant to the reaction conditions and gives better overview of the catalytic chemistry. Novel term *operando* spectroscopy has been introduced in the context of catalysis literature at the beginning of the 21st century. Its meaning specifies the importance of combining fundamental spectroscopic surface phenomenon with catalytic performance, at the same time and on the same sample, under realistic reaction conditions. Understanding the pathways how a substrate molecule is transformed into a product and how it interacts with a surface of the catalytic material is a curiosity-driven challenge. Although many chemists put a lot of effort to demystify catalytic processes, the number of cases requiring deeper understanding is still growing.

The highest priority of this project will be placed on the enhancement of the coupled Atomic Force Microscopy and Raman Spectroscopy (AFM/Raman) in order to obtain the desired level of spatial resolution with chemical information. The improvement of the analysis methods will result in a significant impact on the new possibility to determine structure-activity/selectivity relationships of active sites. Simultaneous usage of complementary detectors enables to monitor surface intermediates, their formation and disappearance. The closer look at the structure of active sites present on the catalyst surface will bring new sight into their nature and thereby possibility to design improved or even new catalytic materials to increase the conversion and selectivity towards the desired reaction product. Most noteworthy, the project results will facilitate the rational design process on the atomic scale and advance in modern Catalytic Material Engineering.