At the present time, the World is grapple with the problem of polluted air, one of the reasons for this is undoubtedly the use of fossil fuels in transportation. In order to reduce the emission of carbon dioxide and nitrogen oxides, it would be necessary to reduce the usage of these fuels in transportation and increase the usage of so-called “clean fuel”. In this context, hydrogen, which is the most plentiful element in the universe, is often presented as an attractive alternative fuel because it is the cleanest fuel ever discovered, and water is the only product of its combustion. Hydrogen is a high-energy fuel in relation to most of fuels. In addition, hydrogen can be used in fuel cells to generate electricity that can be efficiently converted into mechanical energy. Currently, the commercialization of fuel cells faces a problem related to the supply and storage of hydrogen or its production in mobile sources. Hydrogen can be stored in high-pressure cylinders, however, it involves high costs of its compression and risk of explosion with poor public acceptance. Moreover, due to the low hydrogen density, its storage in this form is inefficient. More safe and attractive methods for the physical storage of hydrogen are its adsorption on porous materials, such as zeolites, porous carbons, microporous polymers and metal-organic frameworks. However, at present, these materials are unable to store and release hydrogen in the required amounts, and in most cases, filling them with hydrogen requires very low temperatures close to temperature of liquid nitrogen. An alternative to physical storage of hydrogen is its storage in the form of chemical compounds, in addition to hydrocarbons, by means of which carbon dioxide emissions are involved, ammonia appears to be a good choice because it is carbon-free compound. The use of liquid ammonia due to its toxicity and odour may be unacceptable. However, there are a number of solid substances that can safely store a large amount of ammonia and release it as needed.

The main aim of the proposed research project is to develop a high performance catalyst for ammonia decomposition to produce hydrogen, which can be used in fuel cells for electricity generating. The basic concept of the research will be to develop hybrid nanomaterials by combining layered double hydroxides as precursors of catalytically active components and carbon based layered materials, such as graphene. Nanomaterials will be optimized in terms of chemical composition, the synergetic effect of multimetallic systems and the impact of promoters will be studied.

The expected results of the project should deepen the knowledge about the impact of synergistic effects and catalyst synthesis conditions. Research on the interaction between matter (elements, compounds) will develop knowledge in the field of designing new catalytic systems with improved activity and selectivity. In addition, research into a relatively new class of materials, which is pillared graphene, will expand the field of its applications. The development of environmentally friendly technologies, such as zero-emission alternative fuels, will have a measurable impact on environmental protection. Research on the development of an efficient ammonia decomposition catalyst should extend the use of hydrogen-based technologies as a mobile source of energy.