Ternary and quaternary nitrides of transition metals are a relatively new group of materials studied nowadays. Nitrides containing atoms of one metal within the main structure are called binary nitrides, nitrides containing atoms of two metals are known as ternary or bimetallic nitrides, and containing atoms of three metals as quaternary nitrides. The main goal of the project is a detailed examination of the preparation procedure of three different ternary systems: Co/Mo/N, Fe/Mo/N and Ni/Mo/N as well as three quaternary systems: Co/Fe/Mo/N, Fe/Ni/Mo/N and Ni/Co/Mo/N, to obtain nitrides with particular compositions and physicochemical properties.

These nitrides are extremely hard as well as corrosion-resistive. They are good conductors of heat and electricity. They have found applications as refractory materials, light-emitting diodes, photovoltaic cells, transistors, spintronics materials, supercapacitors, superconducting materials. Magnetic properties of these compounds are very promising. Most of the considered compounds exhibit metallic electrical conductivity. Electrochemical supercapacitor electrode material has been synthesized and consists of γ-Mo_2N and Co_3Mo_3N. Bifunctional electrocatalysts for the oxygen reduction reaction (ORR) were obtained from mesoporous cobalt molybdenum nitride (Co_3Mo_3N).

The prominent field of applications of the ternary and quaternary molybdenum nitrides is catalysis. Their activity exceeds this of more conventional classes of catalysts, such as metals and metal sulfides, and they are claimed to play an important role in large-scale industry. It is worth noting that ternary nitride Co_3Mo_3N exhibits very high catalytic activity in ammonia synthesis.

These inorganic compounds might have a variable composition, which depends on their preparation procedure. Because of that, the viable problem is obtaining a compound with controlled composition and tailored properties. The most widely used procedure to form ternary and quaternary nitrides is a two-stage process consisting of a precursor preparation and a subsequent ammonolysis of mixed oxides. The different routes and methods of precipitation of mixed metal oxides will be studied. This includes simple co-precipitation from water solutions as well as modern methods as double jet or use of surfactants. The mentioned methods usually result in the formation of very dispersed nanometric materials which should be beneficial for catalysts. The influence of the ammonolysis reaction parameters on the structural parameters of the nitrides, such as phase composition, texture and surface development will also be determined. An extensive application of in-situ examination of phase transformations is planned.

As a result of the Project, a better understanding of the reaction routes and mechanisms occurring in these systems is expected. A new knowledge will lead to effective and reproducible procedures to form the products of desired chemical composition, crystallographic structure, and physicochemical properties.