The objective of the project is to characterize the nanomechanical properties of ε-Fe_3N and γ'-Fe_4N iron nitrides produced by a controlled gas nitriding and laser heat treatment (LHT). The gas-nitrided layer of the intended phase composition will be formed. Nitrides are characterized by high hardness, corrosion resistance and good wear resistance.

The first stage of work will consist in a selection of parameters of gas nitriding and laser heat treatment (LHT). Controlled gas nitriding allows to control the phase composition and thickness of the nitride layer. This process is fully controlled by temperature, time and nitriding potential.This gives the possibility of obtaining the layers of controlled composition. Gas nitriding process will be carried out in order to form the two types of nitrided layers in relation to phase composition of compound zone. The first layer will be composed of ε-Fe_3N and ε+γ' (Fe_3N+Fe_4N) iron nitrides close to the surface. The second process will provide the compound zone, including only γ'-Fe_4Niron nitrides. LHT parameters (laser beam power, scanning rate, overlapping) will be specially selected this way that the compound zone will be not re-melted. Such a laser treatment should only modify the microstructure of iron nitrides and harden a part of the diffusion zone below compound zone. During this process, the temperature of the treated surface will be measured using a pyrometer. It will enable to control the laser treatment in order to avoid re-melting of the compound zone. After completed the processes of hybrid heat treatment will be done cross-section metallographic. In the next stage of the research, the microstructure of gas-nitrided layers and hybrid layers (gas-nitrided and laser heat-treated)will be analyzed using optical microscope and scanning electron microscope. The microhardness profiles through the gas-nitrided layers and hybrid layers will be determined using Vickers method. It will enable to analyze the influence of LHT on the hardness of compound zone and diffusion zone as well as to measure the thickness of the produced layers. The nanomechanical properties of iron nitrides will be studied using Fisher nanoindenter with Vickers diamond tip. The indentation hardness and Young's moduli of ε-Fe_3N andγ'-Fe_4N iron nitrides will be studied before and after laser heat treatment. The main objective of this part of the study will to determine hardness and elastic modulus of the iron nitrides ε-Fe_3N oraz γ'-Fe_4N after controlled gas nitriding and hybrid surface treatment.

The main of aims the project consists in the use of laser modification in order to improve the properties of compound zone, especially ε (Fe_3N) iron nitrides. LHT should modify the microstructure of the compound zone resulting in its diminished porosity. It can cause the significant impact of the project results on the development in producing the nitrided layers on steels. The proposed research project will help to define the basic properties of iron nitrides after gas nitriding and laser heat treatment. It will have a significant development of materials science processes of thermo-chemical treatment.