The modern automotive industry, due to the increasingly requirements regarding the level of pollution, focuses on the use of high-strength materials that allow to reduce the total weight of the vehicle. To accomplish this, high-strength steels are used to produce thin-walled components. Thanks to their high strength, it is possible to reduce the thickness of the sheet, and thus the weight of the element, while maintaining safety requirements. However, due to the fact that specific elements of the structure must fulfill specific tasks, such as: energy absorption - in the case of a crumple zone and limiting the possibility of deformation of the elements - safety cage (passenger compartment), a wide range of available materials is necessary. However, the use of aluminum and other light metal alloys, as well as composite materials for body parts, is still reserved for a narrow group of cars, mainly due to high costs. **In recent years, attempts have been made to use high-strength steel sheets with the potential to produce light structures (reducing the thickness of the sheet while maintaining strength and stiffness). The AHSS (Advanced High Strength Steel) steels in question have a multi-phase microstructure that allows for an excellent combination of mechanical and technological properties.**

Currently, medium manganese steels, belonging to the latest generation AHSS, are of great interest to scientists around the world. This is due to the need to develop steel that provides a good combination of strength and plastic properties, at a competitive price, acceptable to the automotive industry. The aspect of meeting these requirements is the presence of residual austenite in these steels. This phase under the influence of deformation (technological shaping or deformation during a road accident) **undergoes a gradual, strain-induced martensitic transformation. This transformation is related to the TRIP (TRansformation Induced Plasticity) effect**, which enables the simultaneous increase in strength and plasticity. As a result, during the production process of the car element, steel sheets made of these steels have high potential for plastic deformation. **Thanks to this, it is possible to produce elements with complex shapes and a geometry allowing for better energy redistribution. Hence, it is possible to produce geometrically developed thin-walled structures that improve the stiffness of the element and have the ability to absorb energy.**

However, in the case of a safety cage, high strength and rigidity of body parts are required. They are designed to resist a collision in order to protect passengers from injuries. At the same time, due to the fact that the main method of joining elements in the automotive industry is welding, these steels must show good weldability. This approach requires scientists to constantly develop the currently used and develop new technological processes to meet these expectations. One of the directions of development is nanotechnology, the task of which is to develop technological processes enabling the production of nanocrystalline structures. **Reducing the grain size of the phases present in the material allows to achieve incomparably higher strength in relation to the microscopic structure.**

Hence, **the aim of the project is to create an innovative heat treatment that allows for the production of nano-bainite structure with ductile residual austenite**. The kinetics of phase transformations during the intercritical annealing and its effect on the martensitic transformation temperature will be analyzed in detail. At the same time, the analysis will cover the change of mechanical properties as a function of isothermal temperature in the area of nano-bainite formation.

The implementation of the research project requires a wide range of comprehensive studies using the latest research techniques and simulation tools used to determine the kinetics of phase transformations, and to evaluate the structural and mechanical properties of the tested material. As part of the submitted project, 2 advanced high-strength model alloys belonging to the latest, third generation AHSS steels will be tested:

- 0.17C-3.1Mn-1.6Al-0.2Si-0.2Mo-0.04Nb
- 0.17C-3.6Mn-1.6Al-0.2Si-0.2Mo-0.04Nb

In the first stage of the project, thermodynamic calculations will be carried out using the latest software, allowing to determine changes in the material during heating and cooling. Based on the results of these activities, it will be possible to proceed to the experimental stage aimed at their verification and development of optimal conditions for the heat treatment processes. At the same time, the experimental data will be used to verify and modify the currently used model in order to adapt it to this group of advanced steels.