The modern automotive industry is guided by two main development trends in the area of materials. The first is to reduce the weight of the car, which is directly related to reducing fuel consumption and thus reducing exhaust emissions. In practice, this is difficult to achieve due to the ever-increasing number of additional equipment designed to ensure passenger comfort. For this reason, it is important to strive to reduce the weight of the car structure in which additional elements are installed. However, this philosophy is at odds with the second trend of development, which aims to improve passenger safety. The use of aluminum alloys and other light metal alloys, as well as composite materials for structural elements, are still reserved for a small 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 lightweight structures (reducing sheet thickness while maintaining strength and stiffness). The discussed AHSS (Advanced High Strength Steel) steels have a multi-phase microstructure that allows for a perfect combination of mechanical and technological properties.**

Currently, researchers are very interested in **medium-Mn steels, belonging to the latest generation of AHSS.** This is due to their retained austenite phase. This phase undergoes a gradual, **deformation-induced martensitic transformation** under the deformation (technological shaping or deformation during a road accident). Martensitic transformation usually occurs during the quenching of the steel, so it can be said that medium-Mn steels are partly quenched by strain. This transformation is related to the occurrence of the **TRIP (TRansformation Induced Plasticity) effect, which enables a simultaneous increase in strength and plasticity.** As a result, in the initial phase of the production process of a car element, the sheet made of these steels is plastic and susceptible to shaping (stamping, bending, etc.). **This allows for the production of geometrically developed thin-walled structures that improve the stiffness of the element and have the ability to absorb energy.** During a forming process such as stamping (or a traffic accident), the material gradually hardens, significantly increasing its strength and delaying its failure (plasticity reserve). Thus, such material is predisposed to be used in crumple zones and the most responsible structural elements of a car.

It is therefore advisable for the steel to have the largest possible share of this active phase. It is usually obtained through specialized heat treatment - intercritical annealing. Despite high ductility, intercritically annealed medium-Mn steels suffer from problems of limited strength and non-uniform deformation. It is assumed that solving these problems is possible by replacing the ferritic matrix with tempered martensite in the newly proposed variants of heat treatment. They are also intended to shorten the production process from many hours to less than 30 minutes and increase its environmental friendliness.

Therefore, the aim of the project is to explain the phase transformations occurring in two novel variants of heat treatment of medium-Mn hot-rolled steels – shortened intercritical annealing process and Q&P treatment, the evolution of their microstructure and the structural interactions between the retained austenite, the tempered martensite matrix and the deformation-induced martensite.

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

- model alloy type 0.17C-5Mn-1.5Al-0.2Si-0.2Mo,
- model alloy type 0.17C-5Mn-1.5Al-0.2Si-0.2Mo-0.03Nb with a micro addition of niobium.

In the first stage of the project, thermodynamic simulations will be carried out using the latest software, allowing to determine the changes occurring in the material during the given heating, annealing and cooling cycles. Based on the results of these activities, it will be possible to proceed to the experimental stage, aimed at verifying them and developing optimal conditions for the shortened intercritical annealing process and Q&P treatment, allowing for an increase in the strength of the material while maintaining its good plasticity. Such a multi-phase material will meet the stringent requirements of the automotive industry, and at the same time is an economical solution.