Description for the general public

The priority of modern automotive industry is reduction of car body weight related directly to the reduction of petrol and pollution emissions. In practice, this is hard to achieve because the total mass of modern cars is increased by additional equipment, which increase safety and comfort of passengers during travel. That is why an optimal reduction in mass of car body is important, in which the additional elements are mounted. The use of aluminum alloys and another non-ferrous alloys or composites materials for car bodies is still limited to a narrow group of cars, mainly because of high manufacturing costs. **In recent years attempts are made for use of high strength steel sheets, with high potential for manufacturing of light-weight structures (minimalization of sheet thickness). These steels have multiphase microstructure and are marked as AHSS (Advanced High Strength Steel). These steels are characterized by excellent combination of mechanical and technological properties.**

Ensuring safety is achieved by improving both active and passive safety. The area of passive safety includes a proper material design and construction projecting oriented to manufacturing of energy absorbing thin-walled structures, placed in crumple zones of a car. It is essential to know the behavior of advanced high strength steels during sheet processing and under dynamic loads, which are characteristic for car crash events. **It turns out that the mechanical properties of metal alloys are strongly affected by temperature and strain rate.** During forming of steel sheets the friction causes the generation of heat, and in car crashes conditions the elements of car body are exposed to both high temperature and high strain rates.

One of main components of AHSS microstructure is retained austenite, which undergous strain-induced martensitic transformation during deformation that takes place during forming or car crash events. This transformation is associated with the occurrence of TRIP effect (TRansformation Induced Plasticity), which leads to increase of both strength and plasticity, thereby qualifies these materials for the use in crumple zones. Mechanism of this transformation is well known and described for static deformation conditions in room temperature. **However, there is no explanation of TRIP effect mechanism at high temperatures and at high strain rates, especially in case of III generation AHSS, including medium-Mn steels.**

Therefore, the aim of the project is to explain the effects of temperature and strain rate on the strengthening mechanism and structural interactions between retained austenite and strain-induced martensite in three groups of advanced high strength steels with different manganese contents.

For realization of the project, a wide range of complex experimental tasks is needed, using the most modern research methods and simulation equipment for the analysis of structure and mechanical properties of modern metallic materials. **Within a frame of the proposed project, six high strength steels belonging to different groups of AHSS steels will be examined:**

- 0.24C-1.5Mn-0.9Si-0.4Al-Nb-Ti type low-Mn steel, that belongs to I generation of AHSS
- 0.04C-25Mn-3Si-3Al-Nb-Ti type high-Mn steel, that belongs to II generation of AHSS
- 4 different medium-Mn steels of 0.17C-3Mn-1.5Al, 0.17C-3Mn-1.5Al-Nb, 0.17C-5Mn-1.5Al and 0.17C-5Mn-1.5Al-Nb types, belonging to III generation of AHSS.

During crash events the strain rate may exceed 250 s^{-1}, and in some places of deformation concentration it comes up to 1000 s^{-1}. In these cases the temperature in a range of 50-150°C is generated, similar like during forming (deep drawing) of steels sheets. Within a frame of the project laboratory tests that will allow to obtain this range of strain rate under dynamic tensile and compression conditions and under static deformation conditions with a temperature in a range from -40°C to +200°C, will be performed. The realization of the project aim needs detailed research and microstructure analyses with qualitative and quantitative description of relationships between deformation conditions, microstructure and mechanical properties of investigated advanced high strength steels.