Aluminum alloys feature an attractive strength-to-density ratio making them the primary choice for lightweight structural parts, especially in the automotive industry. High mechanical strength of aluminum alloys can be tailored by a two-stage heat treatment – supersaturation and ageing. The final effect of enhanced mechanical properties originate from the solid state phase transformation which results in very fine, homogeneously distributed precipitates. This treatment is called precipitation strengthening and is available for selected alloys only.

Depending on the main alloying element several aluminum alloys series can be distinguished, Al-Mg-Si, Al-Zn or Al-Cu, each of them feature different precipitates. These alloys are among the most widely applied in industry and their precipitation sequences are well known. The never-ending need for stronger materials requires constant research and development of new materials, including precipitation strengthened aluminum alloys.

One of the latest trends in this topic is so-called hybrid alloys which combine precipitates from different systems. Nowadays, they are treated with conventional heating conditions. However, a complicated chemical composition suggests that there is a possibility to obtain even higher mechanical strength when this treatment is designed in regard to various precipitation mechanisms. The general goal of this project is to design a new alloy and heat treatment which enables precipitation of phases of different systems. The main approach to achieve planned results is to separate nucleation and growth of different precipitates by microalloying. The new alloy will be based on the Al-Mg-Si system which is known for precipitation phenomena sensitivity to a heat treatment.

The main technique applied in order to induce precipitation is a carefully designed heat treatment procedure. As already mentioned, two stages are required. They are separated with the room temperature hold (resulting from the necessity of transport between furnaces or storage purposes). A room temperature exposition leads to an unwanted effect called natural ageing which impacts the final strength obtained during ageing of Al-Mg-Si alloys, then it should be minimized. The main purpose of chemical composition microalloying proposed in this project is to hinder room temperature precipitation phenomena of Al-Mg-Si but enabling those of different elements (Cu or Zn). It is possible when new alloying elements will form metastable complexes with Mg-Si but not with Cu or Zn. Then, unavoidable room temperature exposition may provide a beneficial effect on the final properties tailored in the second stage of heat treatment. As a next step, metastable complexes of Mg-Si and alloying elements will be dissolved at elevated temperature (typical for ageing) allowing nucleation and growth of Al-Mg-Si precipitates. The previously nucleated phases of Cu or Zn will grow at the same time leading to a complex precipitates conditions of phases typical for two systems.

Selection of the alloying additions will be based on a database for interactions between alloying elements in aluminum alloys (published recently in *Acta Materialia*) and thermodynamic modeling with use of ThermoCalc software. Verification of possibility of precipitation strengthening will be carried out with differential calorimetry. The effect of applied heat treatment on mechanical properties will be evaluated with hardness measurements. Microstructure studies will be performed with transmission electron microscopy.

The project will result in the new alloy and heat treatment, which lead to the increased mechanical properties, suited for this particular material. A complex precipitation conditions will provide the level of mechanical strength higher than for conventional alloys.