The primary purpose of the proposed project is the synthesis and properties examination of advanced bulk magnesium–iron (Mg-Fe) nanocomposites. The idea of forming the nanocomposites is connected with the Mg_2FeH_6 hydride decomposition, followed by sintering, pressing, and cold rolling. The need for ternary magnesium-iron hydride synthesis is based on the element's non-solubility (accordingly to the phase diagram). Moreover, both elements do not create intermetallic phases and solid solutions, and the differences between their densities and melting temperatures are significant. As a result of this ternary hydride decomposition, the composite structure consisted of a magnesium matrix with nanometric-sized iron particles incorporated in it will be composed (accordingly to the formula below):

$$Mg_2FeH_6 \rightarrow 2Mg + Fe + H_2\uparrow$$

Generally, materials confined to nanoscale obtain properties different from those characteristic for the bulk form. Nanocomposites are defined as multiphase material with at least one phase possessing dimensions below dozens of nm. The mechanical, electrical, optical, thermal, and magnetic properties of that type of material may differ significantly from classical composites. Moreover, combining two no-soluble in each other elements with different densities, mechanical strength, and thermal conductivity may result in receiving a quite interesting composite, especially when one phase can exist in the form of nanoparticles.

The nanoconfinement matter is still broadly investigated, and those results may give significant input to the current knowledge of its influence on the properties of the materials. Moreover, it would be beneficial to explore materials associated with increasing the properties-to-density ratio. In case of finding any abnormal behavior and outcome, it can result in the application of described material in a different type of sensors, heat sinks, memory cells, or even as the modern structural material of very low density (automotive industry).

Magnesium alloys have become attractive structural and functional materials due to their very low density and ideal hydrogen storage properties. Magnesium has 36% and 78% lower density than aluminum and iron, respectively. Moreover, it has high specific stiffness and strength, good electrical conductivity, and recyclability. On the other hand, iron is the most universal of the transition metals and the fourth most abundant element in the Earth's crust. Both of the elements are broadly investigated in theirs bulk form. Still, nanoparticles have attracted researcher's special attention for many reasons (due to the properties owing to their nano-sizes). Constantly increasing energy costs and climate change awareness are the driving force for finding new solutions. Over the last few years, the average vehicle mass was reduced by ~140 kg. It is a result of light materials applications (mostly aluminum in that case).

The proposed research has simply a cognitive character and will answer the arising questions if an advanced iron-magnesium nanocomposite material possesses unique mechanical, transport, thermal, and magnetic properties. It can lead to its practical application due to the potential combination of high strength and low density. It will also result in the possibility of synthesis and studying less-known interactions between magnesium and iron. Moreover, the significant difference of the iron and magnesium melting temperatures makes it interesting to study as a thermomechanical behavior model material.