Many interesting effects in solids, which result from to the coupling of magnetic sublattice with a magnetic field, may be exposed with changing the latter. Among others, it concerns the magneto-thermodynamic effect, that is also known as magnetocaloric effect (MCE), which manifests itself in the absorption or emittion of heat by a solid under external magnetic field change. The effect is observed in all magnetic materials. In recent years, magnetic refrigeration has become an attractive alternative to conventional gas-compression-based cooling technology since it is more efficient as well as environment friendly and can be implemented in a wide temperature range, from near-room to ultra-low temperatures. Up to now significant work has been done while searching for new refrigerants with advanced magnetocaloric properties.

Modern society uses liquefied gases, such as helium, for cooling superconducting magnets in many important research and technical fields. First of all, the superconductivity allows one to create high magnetic fields at low energy consumption. In medicine, for example, so-called NMR-tomography is widely used. The traditional superconducting material is NbTi alloy having a critical superconducting transition temperature of 9 K and a critical field of 12 T; almost 80 % of the produced alloy is used to design electromagnets needed for the medical diagnosis by nuclear magnetic resonance. The remaining 20 % is used for the construction of electromagnets for research purposes. In spite of the high degree of thermal insulation of evacuated protective layer and an intermediate layer of liquid nitrogen, losses of helium in the cryostat are inevitable because of the evaporation.

The aim of the project is to develop an innovative method of obtaining composite refrigerants using isostatic high-pressure synthesis. The composites $R_{1-x}R`_{x}Ni_2$ (R, R` – heavy rare-earth metals) will include magnetic intermetallic compounds with a Laves phase structure. Selected starting compounds belong to the group of materials exhibiting a large magnetocaloric effect (MCE) and some of the $RNi_2$ compounds show promise as ideal refrigerant~~s~~ materials at low temperatures. In the ternary solid solutions, comprising two heavy lanthanides and nickel we will obtain refrigerant materials with the desired properties, from which it will be possible to build a composite material that works as a refrigerant in the temperature range from 4.2 to 40 K.

The composite material obtained through the innovative high-pressure synthesis could be used in the future as a refrigerant in cryogenic magnetic cooler working in a low temperature range. This refrigerator would be a kind of insulator (thermal barrier) between the cryogenic liquid and environment; thereby, the consumption of cryogenic liquids, which evaporate during operation of the cryogenic equipment, storage and transportation, would be considerably reduced.

Results of deep and comprehensive research of new functional materials with high MCE in low-temperature range will enlarge knowledge in this field of functional cryogenic materials. The results of the most reliable direct measurements of MCE in high stationary magnetic fields up to 14 T are of special interest. The new methods for direct experimental studies namely, direct measurements of $\Delta T_{ad}$ and $\Delta Q$ under adiabatic and quasi-isothermal conditions will be implemented in the framework of the present project. It is worth noting that the $\Delta Q$ measurement indicates the novelty of the proposed project. Such measurement requires the use of appropriate experimental conditions and is not used by research canters dealing with the subject of MCE. Therefore, most scientific articles related to MCE are based on magnetic, transport or direct measurements. However, from a practical point of view, the use of a method that will allow us to estimate the value of absorbed or given heat seems to be the most justified and rational.