The main objective of the project is to perform an in-depth analysis of the fatigue properties of a wide range of materials based on Ni-Mn-Ga alloys obtained by the melt spinning method. This method produces material in the form of thin ribbons several micrometers thick. In the current year (i.e. 2021), the principle investigator of this proposal has recently published a paper, in which for the first time, the so-called magnetic field-induced bending (MFIB) effect has been shown in Ni-Mn-Ga-based alloys produced by the melt spinning method. In principle, this behavior resembles that of a fixed ferromagnet, for instance an iron wire, deflecting in a magnetic field applied at the free end of a beam. Then bending effect comes about due to the magnetic torque. Unlike iron wire though, which largely deflects elastically, magnetic shape memory alloys (MSMA) on deflection have been demonstrated to accommodate some degree of plastic deformation. Strain in this case stems from variant reorientation imposed by stress induced due to the magnetic torque. Although, in typical transducer and actuator applications of MSMA, the MFIB can be detrimental, leading to friction and limited cycle lifespan, it can turnout advantageous for novel functional applications of MSMA in e.g. propulsion mechanisms bio-mimicking fins or tadpole tails. In this respect Ni-Mn-Ga based melt-spun ribbons with average aspect ratios exceeding 100 turnout exceptionally attractive owing to an exclusive ribbon geometry as well as to the ease and scalability of the melt spinning technique itself. For illustration a giant MFIB effect has been recently reported in quinary $Ni_{45}Mn_{25}Ga_{20}Co_5Cu_5$ melt-spun ribbons.

From this point of view, the fatigue analysis of this kind of material subjected to cyclic bending effect induced by external magnetic field as well as external load of mechanical nature is an important issue for further experimental exploitation, which is the main goal of this project.

The material produced by this method has a strong anisotropy of microstructure along the cross section. Thus, the project involves the analysis of fatigue properties in a highly anisotropic materials from the microstructure point of view. Therefore, different fatigue properties depending on the geometry of the ribbon, in reference to the external load as well as the direction of the external magnetic field, are also to be expected.

Another research objective will be to analyze the effect of heat treatment of the as-cast ribbons and the influence of this treatment on their fatigue properties. It is assumed that the heat treatment will strongly modify the microstructure, the internal stress of the obtained ribbons, as well as increase the degree of atomic ordering. An attempt will be made to distinguish the influence of the recovery phenomenon from the subsequent recrystallization stage on the fatigue properties of this material. As a result of this in-depth analysis, it will be possible to optimize the applied heat treatment in order to maximize cycles during fatigue tests while maintaining the functional properties of the material. The project will also investigate the effect of chemical composition on fatigue properties.

Therefore, a total of 25 sets of ribbons of different chemical compositions will be produced and analyzed for their fatigue magneto-mechanical properties, as well as subjected to in-depth microstructural and phase analysis and analysis of the influence of heat treatment and associated microstructural changes on fatigue properties and their optimization .Such an extensively planned research project will provide a huge database that will enable the design of this type of materials and to optimize their functional properties.