Soft **M**agnetic **M**aterials (SMMs) have attracted much attention due to their unique properties such as high saturation magnetization, permeability and resistivity as well as low coercivity and core losses which ensure high potential for application in electrical power generation and transformation and as sensors. The lowest possible coercivity and the highest possible electrical resistivity are the most important goals for SMMs allowing for the reduction of hysteresis-related and eddy-current-related energy losses, noise and the material damage. Moreover, the next criterium of new SMMs is associated with higher strength, including high hardness and fracture toughness, and ductility to make possible working under loading conditions necessary for applications in transport and energy. Thus, the most challenging is to find the balance between soft magnetic properties and strength of materials. In light of the above, the new concept of HEA seems to be very attractive since it allows tuning the microstructure by chemical composition and postponing heat treatment.

In this project, FeCoNiXY and CoFeCrXYZ (X = Ta, B, Y= Al, Ti) high entropy systems i.e. with *fcc* and *bcc* crystal structures will be studied. In general, the fcc structure is more prone to accommodate plastic deformation and thus less brittle while the Fe-based bcc structure possesses very good magnetic properties with Fe being in fact, the strongest ferromagnetic metal. Furthermore, three manufacturing processes such as classic induction casting followed by the plastic deformation by rolling, melt-spinning processes and powder metallurgy process based on mechanical allowing combined with spark plasma sintering are planning to applied. For all fabricated samples the heat treatment will be elaborate in order to initiate the precipitation hardening due to coherent precipitates in the refined metastable solid solution matrix. Mainly the research project will be oscillate around the following issues: (i) thermodynamic in order to select the best compositions of FeCoNiXY and CoFeCrXY (X = Ta, B,Y = Al, Ti); (ii) process parameters of manufacturing and heat treatment of polycrystalline samples; (iii) crystal structure and microstructure investigations in order to understand the interaction of atoms and the role of particular alloying elements in the given systems; (iv) detailed examination of chemical order to describe its correlation with magnetic properties; (v) tuning the precipitation size and degree of coherence; (vi) control of crystallographic texture, grain size; (vii) very detailed magnetic characterization.

All of the aforementioned objectives will be considered by using various complementary techniques as scanning and transmission electron microscopy, electron backscattered diffraction, high energy X-ray diffraction, differential scanning calorimetry. The functional properties will be analysed during magnetic measurements and mechanical tests during tension and compression. Moreover, modelling of alloys chemical composition will be a key to optimize alloys properties. The project will be implemented in a consortium by two research groups specializing in comprehensive studies of soft magnetic materials.