Nowadays, the most popular magnets are based on the $Nd_2Fe_{14}B$ phase, which crystallizes in $P4_2/mnm$ structure. This phase is characterized by very high magnetocrystalline anisotropy, being the origin of energy product $(BH)_{max}$ reaching up to 56 MGOe [1]. Hard magnetic materials are used in electric motors of very different kinds, as well as in consumer electronics and hard disk drives. Development of the magnetic materials is connected with the investigations on renewable sources of energy called "green energy". Recently, due to the rising prices of lanthanides, especially Dy, which improves thermal stability of the Nd-Fe-B alloys [2], the considerable attention of scientist has been attracted by permanent magnets without rare-earth elements.

The main goal of our project is to investigate the influence of composition, structure, as well as the crystalline/nanocrystalline phases ratio and grain sizes on the characteristic magnetic properties, namely magnetization, anisotropy constant, coercivity and energy product $(BH)_{max}$, in two main groups of magnetic systems without rare-earth elements. The master compounds $Hf_2Co_{11}B$ and $(Fe_{0.7}Co_{0.3})_2B$ will be modified by substitution of 3*d* and 5*d* elements. Chosen compositions needs to fulfil criterion of good glass forming ability to ensure the formation of amorphous/metastable phases during synthesis by melt-spinning process. The criterion is determined on the basis of the semi-empirical Miedema's model, also known as the macroscopic-atom model [3]. The glass forming ability (GFA) is evaluated by comparison of formation enthalpies of systems competing during solidification process, so mainly of amorphous and solid solution phases.

The morphology and the structure of the alloys are the most critical elements that influence the magnetic properties. The synthesized metastable phases can be structurally and morphologically modified by isothermal annealing and high pressure torsion (HPT) technique. The second method can reduce the grain size of the crystalline phase, even causing full amorphization, what creates the possibilities to optimize *e.g.* coercive field and saturation magnetization. Additionally, it allows to control the exchange coupling between different magnetic phases in multiphase alloys.

Glass forming ability will be calculated by use of by semi-empirical modeling on the basis of the Miedema's and geometric models [3]. The metastable alloys (amorphous or nanocrystalline) will be prepared by melt-spinning method. Calorimetric studies will give the answer on the thermal stability and activation energy of the investigated alloys. Structural and microstructural investigation will be conducted with the use of x-ray diffraction and transmission electron microscopy. Temperature and magnetic field dependences of magnetization will be measured to describe magnetic properties of each alloy.

The project will benefit in the scientific findings regarding the factors governing the formation of high coercivity rare-earth-free compounds. The knowledge of various factors (type of the major elements, additions of minor elements, chemical composition, fabrication methods and their parameters) influencing the structure and indirectly magnetic properties of the materials discussed is very limited. It is expected that structural disorder introduced by HPT method and appropriate substitution will allow to optimize/enhance magnetic properties, especially energy product $(BH)_{max}$, in comparison to the isothermally annealed sample [4].

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