Survey of Routes for Formation of $L1_0$ Phase in Fe-Ni Based Alloys

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Abstract. Chemically-ordered equiatomic FeNi with tetragonal $L1_0$ structure exhibits permanent magnetization and high coercivity, providing magnetic energy product with theoretical value above 300 kJ m^{-3}, which classifies it thus among excellent rare-earth free permanent magnets. This material, known as tetrataenite, occurs in chondrite meteorites cooled extremely slowly below the temperature of transformation (~320 ^oC) from taenite with disordered fcc structure into tetragonal $L1_0$ structure with ordering of Fe and Ni atoms. Synthetically this material has so far been produced only in minimal quantities by irradiation or by hydrogen-reduction of nanocrystalline NiFe oxides. The bottleneck for its preparation by metallurgical routes lies in minimal driving force for its formation from FeNi alloys due to low diffusivity of constituent Fe and Ni atoms below the transformation temperature. This contribution will analyze the possibilities to circumvent this bottleneck by using FeNi-based precursors prepared in metastable state which subsequently transform close to this temperature into more stable structures, enhancing thus the mobility of constituent atoms. Additional impetus for the formation of ordered FeNi will be sought by applying unconventional methods of alloy processing, mainly rapid and cyclic annealing and magnetic field annealing of rapidly quenched FeNi-based systems alloyed with Si, Nb, P, C and B. The focus of the contribution will be put on the analysis of competing formation of bcc and fcc FeNi from amorphous matrix and its control by unconventional processing to obtain precursor structures with potential to transform into ordered $L1_0$ FeNi.

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