ABSTRACT

The FeNbCuSiB based alloys owing to their ultrasoft magnetic properties have potential application as sensor material. These alloys containing Al and Mn as trace elements were prepared as ribbons by rapid solidification route using melt spinning technique. Process parameters like crucible nozzle diameter and its distance from the quenching wheel affected the quality of ribbons. The wheel velocity representing the quench rate affected the crystallisation, magnetic and mechanical properties of the FeNbCuSiB based alloys. The role of nucleating element (M) in the FeNbCuSiB (M=Cu, Mn, Pt) system was investigated. Magnetic property evaluation showed that $Fe_{73.5}Nb_3Cu_1Si_{13.5}B_9$ alloy containing Cu exhibited much superior soft magnetic properties alloys containing Mn and Pt. In Mn and Pt contained alloys the formation of intermetallic phases along with Fe_3Si was the cause of deterioration in their soft magnetic properties. Therefore, with Cu as the nucleating element in the system, the role of metalloids Si and B in $Fe_{73.5}Nb_3Cu_1Si_{22.5-X}B_X$ (x = 5,9,10,11.25,19) alloys was investigated. Studies showed that formation of α-Fe(Si) and / or Fe_3Si nanoparticles were responsible for superior soft magnetic properties of x = 9 alloy annealed around 800K. The early appearance of strongly magnetoanisotropic boride phases was the cause of deterioration in soft magnetic properties in x = 5, 10, 11.25 and 19 alloys. To further improve the soft magnetic properties, the effect of extra alloying elements, Al and Mn on the FeNbCuSiB system was investigated. On annealing it was found that the developed alloy containing a critical content of Al (2.7at%) exhibited ultrasoft magnetic properties with minimum coercivity of 0.32A/m(4mOe) and susceptibility of 2.0 $x10^5$ which was much superior to the properties so far. This improvement was due to the lowering of the magnetocrystalline anisotropy by the α-Fe(Si,Al) nanophase formed. TEM studies evidenced the formation of nanoparticles beyond an optimum annealing temperature of 775K. The variation of surface roughness observed from AFM studies also corroborated the crystallisation behaviour.