Tailoring the nano-structure of high Bs $Fe_{83.3}Si_4B_8P_4Cu_{0.7}$ soft magnetic alloys

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Most popular nano-crystalline alloys are FINEMET, NANOPERM and HITPERM. Recently, a new kind of nano-crystalline alloy "NANOMET (FeSiBPCu)" is developed. Crystallization of FINEMET is independent of heating rate, whereas NANOPERM and NANOMET alloys need high heating rate (>200 C/min). Motivation of present work is to make nano-crystallization process/magnetic properties independent of heating rate. For this, amorphous ribbons of $Fe_{83.3}Si_4B_8P_4Cu_{0.7}$ were prepared by melt-spinning. The optimum annealing temperature for nanocrystallization (Hc $<$ 10 A/m and Bs $\sim$ 1.8 T) is $\sim$ 460 C. The microstructure/magnetic properties strongly depend on the heating rate. Rapid decrease in Hc with increasing heating rate was noticed and it is due to decrease in grain size. Sudden increase in crystalline volume fraction with annealing temperature is associated with the nucleation of large number of grains. By separating the nucleation and growth process, heating rate dependence in microstructure/magnetic properties was suppressed. Two step annealing process is proposed. First step is to create a large number of nuclei's whereas second step is for growth. The growth of nuclei's is shown to be independent of heating rate. Further details on structure/magnetic properties and their correlation will be presented.