Effects of ball milling on powder shape and magnetic properties in purverized nanocrystalline Fe-Si-B-Nb-Cu alloy

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Nanocrystalline Fe-Si-B based alloys have been intensively studied because of their excellent soft magnetic behavior. It is well known that the magnetic properties of the FeSiBCuNb alloys are significantly influenced by the size ofgrains embedded in amorphous matrix. The morphology of the particles in the FeSiBCuNb powder is another important factor influencing the magnetic properties of the alloys. In this work, the effect of the morphology of FeSiBCuNb powder on the magnetic behavior has been investigated.

FeSiBCuNb amorphous ribbons produced by planar flow casting were annealed at 540C for 40 minutes for crystallization. The microstructure of the annealed ribbon had a ultra-fine Fe(Si) grains, with sizes ranging from 10 to 20 nm in diameter. After the annealing, the ribbons were crushed into flake shape powders using a pin crusher and a hammer mill. In order to modify the morphology of the particles, the FeSiBNbCu powders were ball milled with Sus 304S balls of 3 mm diameter at a powder/ball weight ratio of 1/20 and ball milling time ranging from 0.5 to 24hours. The flake-to-spherical transition during ball milling of nanocrystalline FeSiBNbCu alloy powder was investigated by X-ray diffractometry, scanning electron microscopy and differential scanning calorimetry. The magnetic properties of the specimens were estimated using a vibrating sample magnetometer (VSM).

Results show that the microstructures and morphology of the powders were significantly changed by ball milling conditions. As the milling time increased, the nanocrystalline grains exhibited grain growth. The morphology of the particles in the powder were also changed from flakes to spheroids. The magnetic behavior of the FeSiBCuNb alloys will be discussed in terms of the ball-milling conditions and the morphology of the powders.