Recent progress in amorphous and nanocrystalline magnetic materials

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Soft magnetic materials play an important role to improve efficiency of energy conversion devices. Many efforts have been made in conventional materials such as grain-oriented and non-grain oriented silicon steels to reduce core loss. Their magnetic characteristics, however, are primarily governed by magneto-crystalline anisotropy which is related to hysteresis loss. In addition, it is difficult to achieve large reduction of eddy current loss, considering the cost to produce thin gauge, less than 100 μm, materials.

In amorphous and nanocrystalline materials, magneto-crystalline anisotropy is vanished or tremendously reduced as explained by random anisotropy models [1],[2], and the typical thickness ranging from 20 - 30 μm due to unique production techniques of rapid solidification process and a relatively high electrical resistivity of 1.0 -1.3 μΩm result in lower eddy current loss. On the other hand, saturation magnetizations of amorphous and nanocrytalline materials are generally lower compared to silicon steels due to the presence of metalloids and/or other paramagnetic elements such as Cu, Nb etc. Another challenge in using these materials is to manage brittleness after heat treatments. To overcome these difficulties, rapid heating techniques whose heating rates are more than 10 times higher than those of conventional heat treatment are employed [3]-[6]. This paper reviews recent advances in amorphous and nanocrytalline soft magnetic materials in terms of improvement of brittleness of Fe-based amorphous materials and higher saturation magnetization.

References:

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