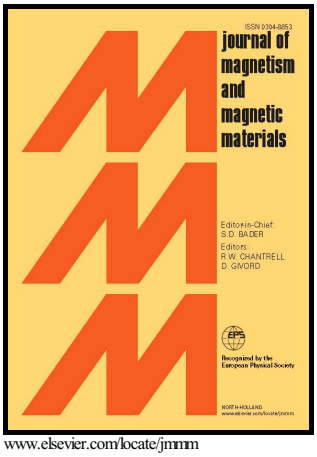

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Iron-borosilicate soft magnetic composites: the correlation between processing parameters and magnetic properties for high frequency applications

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Abstract

Iron-borosilicate soft magnetic composites are suitable magnetic materials for high temperature and high frequency applications. In this research two different techniques have been applied to fabricate these composites: uniaxial pressing following by sintering and spark plasma sintering. Different processing parameters including the content of borosilicate, the amount of compaction pressure and the size of iron particles have been evaluated through the study of microstructure and magnetic properties. The microstructural observations showed that the borosilicate is distributed on the iron grain boundaries enhancing the resistivity and causing the loss of eddy currents. Increasing the compaction pressure was led to the decrease of electrical resistivity. By increasing the frequency both real and imaginary parts of permeability decreased. The use of higher content of borosilicate resulted in the lower decreasing slop of permeability. Best combination of density, permeability and electrical resistivity was obtained in the sample with 2 wt% of borosilicate. In addition, the densification of powders with fine particles was more difficult than coarse particles due to the inter particles friction and bridging effects. Furthermore, as the particles size increases the size of open porosities before sintering where the borosilicate could aggregate enhances. This could yields to the increase in the electrical resistivity. The high ratio of surface to the volume in the powders with fine particles results in the developing the demagnetizing fields and subsequently, decreasing the permeability. The highest relative density (99.99 % of theoretical density) with best distribution of borosilicate was achieved in the composites produced by spark plasma sintering (SPS). The relaxation frequency, obtained from imaginary part of permeability, was found as 340 Hz in the composites made by SPS.