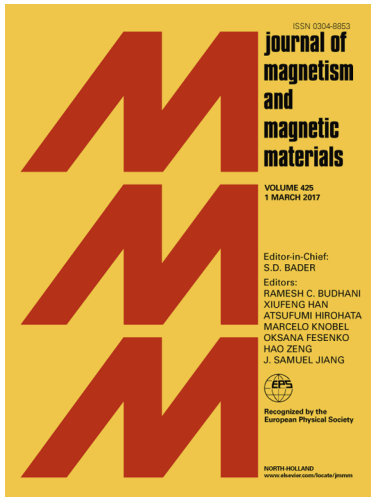

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Two growth mechanisms in one-step fabrication of the oxide matrix for FeSiAl soft magnetic composites

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Abstract

Hydrolysis precipitation as a new method was used in the preparation of oxide insulation matrix for FeSiAl soft magnetic composites (SMCs). The growth and composition of the matrix can be tuned by the concentration of the $Al(NO_3)_3$ solution, reaction temperature and pH value during the hydrolysis. With optimized $Al(NO_3)_3$ concentration of 0.6 mol/L and hydrolysis temperature of 75 °C, two mechanisms have been revealed in the formation of the insulation coating depending on the pH of the $Al(NO_3)_3$ solution. When pH = 3, the coating layer contains a mixture of Al_2O_3 and Fe_2O_3, while Al_2O_3 and SiO_2 form as the coating for pH = 8. Despite that the Al_2O_3 dominates for both conditions, it grows via different routes. The $Al(OH)_3$ as the precursor forms through Al^{3+} hydrolysis and heterogeneous nucleation for pH = 3. With increased pH to 8, the Al^{3+} directly reacts with OH^- to form $Al(OH)_3$ colloidal particles which adsorb onto the surface of FeSiAl powders via electrostatic attraction. Both mechanisms give rise to satisfactory magnetic performance with high effective permeability (μ_e = 103.5 and 113.4) and low core loss (P_{cv} = 278.4 mW·cm^{-3} and 237.8 mW·cm^{-3}) for pH = 3 and 8 measured at 100 mT, 50 kHz.

Keywords: FeSiAl; soft magnetic composites; hydrolysis precipitation; growth mechanism, magnetic properties