11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

Fe-6.5wt%Si thin sheets obtained by spray forming and co-deposition of Fe-Si particles

C. Bolfarini[(1)*], C. S. Kiminami[(1)], W. J. Botta Filho[(1)], R. D. Cava[(2)], D.P. Oliveira[(2)]

(1) Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, Rod. Washington Luis, Km 235, Cx. 676 São Carlos-SP Brasil, e-mail: cbolfa@ufscar.br

(2) Programa de Pós graduação em Ciência e engenharia de Materiais, Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, Rod. Washington Luis, Km 235, Cx. 676 São Carlos-SP Brasil, e-mail: Regis_cava@hotmail.com

* Corresponding author.

Abstract – A 5kg Fe-3,5wt%Si alloy was melted and disintegrated using nitrogen gas in order to produce a composite material using spray forming and co-deposition techniques. Simultaneously, Fe75wt%Si particles corresponding at 3%wtSi were incorporated from one injector to form Fe-6,5wt%Si alloy. Specimens were rolled at 850ºC to the final thickness 0.45mm with 91,3% deformation. Sheets were heat treated at 780ºC and 1250ºC and cooled in air. Were analyzed the microstructural development, grain orientation by EBSD and ordered phases by Mössbauer technique. The treatments lead to the grain growth and diffusion of the particles, resulting in a material with composition 6,5wt% of Si.

Iron alloys containing 6-7wt%Si display high permeability, moderate saturation magnetization, low magnetostriction and low power loss. However, when the Si content is increased above 3.5wt% the alloys become too brittle to allow thermomechanical processing. It has been verified that the B2 long-range ordering is the main cause for such brittleness since it induces the formation of superlattice dislocations and the correlated high stress concentrations leading to premature fracture YU et al [1]. A 3,5kg Fe-3,5wt%Si matrix alloy was first melted and superheated to 1650°C. In order to overcome this problem we produced a composite material using spray forming and co-deposition techniques. The molten alloy was disintegrated using nitrogen at a pressure of 0.80 MPa. Simultaneously, Fe75wt%Si particles in the range of 106-250µm were incorporated into the atomized spray from one injector, positioned at distance of approximately 400mm above the 1020 steel substrate rotating at 60 rpm. Specimens were machined out from the deposit and reheated to 850°C for 5 minutes and hot rolled to the final thickness 0.45mm. The final sheets were heat treated at 780ºC in a protective atmosphere of H_2/H_2O during 8h and cooled in furnace, and subsequently at 1250ºC during 1h and cooled in air. The objective of this work was to investigate the microstructural development, grain orientation by EBSD analysis, ordered phases by Mössbauer in transmission geometry, and the magnetic properties, measured using single sheet specimens in a hysteretic loop tracer at 60Hz/1T and trapezoidal induction waveforms. The treatments lead to the grain growth and the diffusion of the particles, resulting in a material with composition near 6,5wt% of Si.

References

[1] Kasama, A. H. Microestrutura e propriedades magnéticias de chapas laminadas de ligas Fe-Si-Al obtidas através da conformação por spray. 2005. Tese (Doutorado em Ciência e Engenharia de Materiais) – Centro de Ciências Exatas e de Tecnologia, Universidade Federal de São Carlos, São Carlos (2005).

[2] Silva, M. C. A., Bolfarini, C. Kiminami, C. S., Machado, R. and Kaufman, M. J., Magnetic Properties of the Fe-6wt%Si Alloy obtained by Spray Forming . Key Engineering Materials, Vol189-191(2001).