Diffusion of Sn in polycrystalline α-Fe under pulsed magnetic field

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The experimental investigations of Sn diffusion in ferromagnetic α-Fe within the pulsed magnetic field by X-ray diffraction analysis were performed. The pulsed magnetic field was found to influence significantly the diffusion coefficients of Sn in α-Fe.

Pulsed magnetic field was shown [1] to influence significantly hetero-diffusion in ferromagnetic materials. In particular, diffusion of Al and Sn in ferromagnetic α-Fe-based solid solutions reveled a resonant behavior [2, 3] which was explained by a reorientation of atomic pairs in accordance with Zener's mechanism under magnetostrictive stresses imposed by application of the pulsed magnetic field to the α-Fe crystal lattice.

The present study reports the impact of pulsed magnetic field on diffusion of Sn in polycrystalline α-Fe in the temperature interval of 730-830°C. The magnetic field intensity and the frequency are varied in the ranges of 39.8–557.2 kA/m and 1–21 Hz, respectively. The X-ray diffraction analysis is applied to determine the Sn diffusion coefficients. Both, retardation and enhancement of the diffusion coefficient of Sn in α-Fe are observed in dependence on the pulse frequency. The diffusion rate of Sn in α-Fe reveals evidently a resonant behavior which depends substantially on the magnetic field intensity. This behavior is explained by inelastic interactions between the stresses induced by mobile defect complexes (pairs of solute atoms or higher order complexes) and magnetostrictive fields appearing in polycrystalline α-Fe crystal lattice under pulsed magnetic field. Furthermore, elastic interactions of dislocations with moving domain walls during reversal magnetization could provide a further contrition to the observed diffusion behavior.

References

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