Original Article

Diffusion Measurements on Liquid Metallic Materials and Development of Shear Cell (Preparation for Russian Satellite Mission Foton–M2)

Shinsuke SUZUKI, Kurt-Helmut KRAATZ and Günter FROHBERG

Abstract

For exact diffusion measurements of liquid metals we improved the shear cell technique which is available for both under μg-conditions (Foton–M2 satellite mission) and under 1 g-conditions. The main points of the design were minimization of the shear convection, minimization of the Marangoni convection, and improvement of reliable operation. The effect of the shear convection was investigated by short time diffusion experiments both under low-g (parabolic flight in a plane) and under 1 g. As the result the additional mean square diffusion depth caused by the shear convection turned out to be in the order of 10^{-7} m^2, which is smaller than 1% of the usual mean square diffusion depth. We found a correction method for the additional diffusion depth. Using the shear cell diffusion experiments in Sn–Bi, In–Sn, and Al–Ni alloys were performed, with a stable density layering under 1 g-conditions. The concentration profile at each experiment was obtained by the analysis of atom absorption spectroscopy (AAS) and yielded the diffusion coefficient by using the correction method. The diffusion coefficients were the same as the μg-reference data and those from the magnetic field under 1 g-conditions. The temperature dependence of the diffusion coefficient obeyed the power law. On the basis of these results the diffusion types were classified according to the reliability of 1 g-measurement.