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The Open-Access Journal for the Basic Principles of Diffusion Theory, Experiment and Application

Formation of α-(Ti) phase on grain boundaries in Ti-Co alloys

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One of most important processes in the heat treatment of materials is the decomposition of supersaturated solid solutions. The morphology of decomposition products strongly influences the properties of a material. The heterogeneous nucleation of a new phase in a grain boundary (GB) proceeds easier than the homogeneous one in the supersaturated matrix. In the present study a GB wetting is investigated in polycrystalline alloys of Ti with 2 wt.% and 4 wt.% Co in the temperature range from 680 to 880°C.

The alloys were prepared in the induction furnace in vacuum of approximately 10^{-5} Pa. Pure Ti and Co (both of 3N purity) were used for it. For the experiments, ∅10 mm × 5 mm slices of the alloys were annealed in a vacuum of $4{\cdot}10^{-4}$ Pa at 700°C, 730°C, 760°C and 790°C for 720, 720, 816 and 864 hours, respectively. Thereafter, the samples were quenched in water.

Composition of phases in the microstructure of obtained samples was investigated using scanning electron microscope equipped by the LINK energy-dispersive spectrometer. Morphology of the microstructures was analyzed by a light microscopy. It has been found that the solid α-(Ti) phase forms a chain of lenticels-shaped inclusions or continuous homogeneous layer in GBs of β-(Ti, Co) matrix, see Fig. 1(left). A quantitative analysis of the wetting transition in the polycrystalline samples was performed adopting the following criterion: every GB was considered to be wetted only when a solid layer had covered the whole GB. Accordingly, the percentage of wetted GBs was determined. At least 100 GBs of each sample were analyzed. The results are presented in Fig. 1 (right).

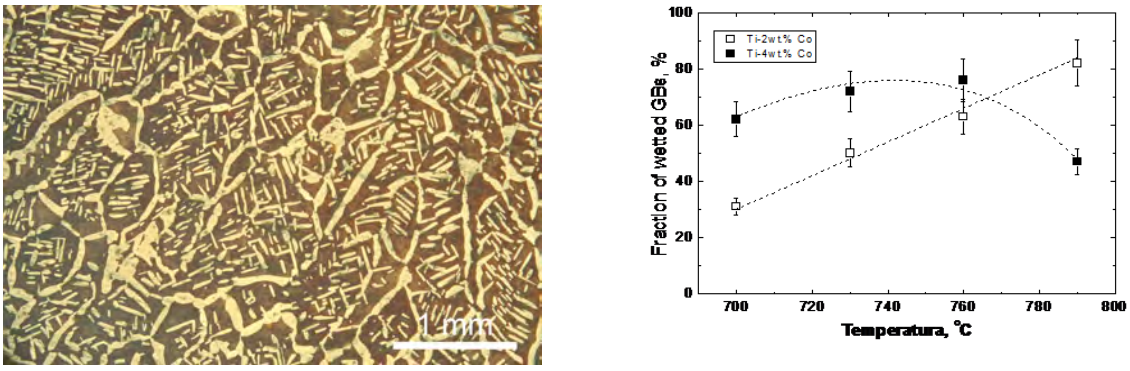

Figure 1: (left) The microstructure of Ti–4 wt.% Co alloy annealed at 760°C, 816 h. The α-Ti phase appears light, the β-(Ti, Co) phase appears dark. (right) Temperature dependence of the fraction ofr completely wetted GBs for alloys: Ti-2wt.% Co and Ti-4wt.% Co.

One can observe that the fraction of completely wetted GBs increases with an annealing temperature for Ti-2wt.% Co alloy. Whereas, this fraction for Ti-4wt.% Co alloy increases until the *solvus* line is approached, and then decreases.

Formation of the chains of single inclusions can be related to the low-energy GBs, where slower diffusion kinetics, smaller density and average size of inclusions, and, then, their slower growth velocity, are expected. In this way, formation of the continuous homogeneous GB layer is associated with high-energy GBs.

The authors acknowledge financial support by the Russian Foundation for Basic Research (contract 12-03-00894).