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MULTILAYER STRUCTURE FORMED IN DIFFUSION ZONE OF Al-Co AND Al-Ni SYSTEMS

Abstract. The Diffusion Zone (DZ) of Al-Co and Al-Ni systems using the diffusion couple method was studied. The microstructure and element composition of samples were studied in cross-sectional geometry by mean of Scanning Electron Microscopy and Electron Probe Microanalysis (SEM/EPMA) and X-rays diffraction. After isothermal treatment in the range between 1000°C and 1375°C the multilayer intermetallic structure has been formed. It was shown that the diffusion couples method demonstrates its efficiency in comparative experiments having cross-sectional geometry. Depending on the established concentration of components in DZ several layers of different phase composition have been formed. The well-known intermetallics having constant compositions were detected: Al_9Co_2, $Al_{13}Co_4$, Al_3Co, AlCo, Al_5Co_2, as well as Al_3Ni_5, Al_4Ni_3, AlNi, $AlNi_3$. New compounds having variable composition were revealed. For of Al-Co system, these four layers were detected after treatment at high temperature (1300-1375 °C): $Al_{21}Co_{79}$ (78.72 at.% Co), $Al_{44}Co_{56}$ (55.69 at.% Co), $Al_{20}Co_{80}$ (79.55 at.% Co), and $Al_{27}Co_{73}$ (73.29 at.% Co). For of Al-Ni system, the corresponding layers having clear boundaries were detected: $Al_{51}Ni_{49}$ (49.07 at.% Ni), $Al_{36}Ni_{64}$ (64.06 at.% Ni), $Al_{30}Ni_{70}$ (69.62 at.% Ni), and $Al_{32}Ni_{68}$ (67.86 at.% Ni).

Similar structural features in multilayer DZ in both systems (porosity, dendrites, and shift of intermetallics having constant composition to higher temperatures), as well as evidence of changes in local densities not only for different layers, but also within one layer, can contribute to specification of application of both systems to AM.

Keywords: diffusion couple, scanning electron microscopy, electron probe microanalysis, X-rays diffraction, diffusion zone, multilayer structure, intermetallics.

Introduction. In case of study of pattern and structure of diffusion zone (DZ) the diffusion couple method can facilitate to disclose the character of element distribution and conditions for the formation of intermetallic layers. This method is based on the close contact between two metals followed by the heat treatment at the corresponding temperature for the period of time sufficient to provide the diffusion redistribution of elements. It is expected that DZ will contain all phases in that subsequence, which is observed for them in the corresponding phase diagram at the given temperature. Therefore one can evaluate the fragments of phase diagrams through measurements of component concentration in each layer.

The concentration discontinuity is considered as the boundary line between on-phase areas in the diagrams. Adjacent phases in layers are considered ones having equilibrium with each other [1]. The DZ method can be also applied for practical purposes, e.g., to enhance the oxidation resistance of Ni-superalloys using NiAl-diffusion coatings [2]. In the most of binary systems, the mutual diffusion is accompanied by the formation of phases: solid solutions existing in the limited range of concentrations, intermetallic phases having the strictly constant composition (stoichiometric compounds, i.e., daltonides), or with variable composition (non-stoichiometric compounds, i.e., berthollides) [1]. From point of view of concentration localization of the berthollides takes the intermediate position between solid solutions and daltonides [1 Page 229, 3].