JPEDAV (2010) 31:447–448
DOI: 10.1007/s11669-010-9742-4
1547-7037 ©ASM International

Al-Co-Fe (Aluminum-Cobalt-Iron)

V. Raghavan

The phase relationships in this system were reviewed by [1988Ray], who presented two partial liquidus surfaces, an isothermal section at 800 °C for Co-rich alloys and isothermal sections at 640 and 600 °C for alloys near the Al corner. A full isothermal section at 650 °C was determined by [1999Koz] and updated by [2002Rag]. [2004Kam] determined the phase relationships in Co-rich alloys between 1200 and 900 °C in the region of magnetic and order–disorder transitions, briefly reviewed by [2005Rag]. [2008Rag] updated the results of [2004Koz] and [2006Koz], who used the liquid-quenching and composition-gradient methods to determine the metastable $B2/(B2 + A2)$ phase boundary at 650 °C in Co-rich alloys. Recently, [2010Gru] studied the phase equilibria of this ternary system at 1070 °C in the Al-rich region.

Binary Systems

In the Al-Co phase diagram [Massalski2], the intermediate phases in the Al-rich region are: Co_2Al_9 (monoclinic), Co_4Al_{13}, and Co_2Al_5 (hexagonal). Four crystalline forms occur around the composition Co_4Al_{13}: o-Co_4Al_{13} (orthorhombic), m-Co_4Al_{13} (monoclinic), Y-Co_4Al_{13} (monoclinic), and Z-Co_4Al_{13} (monoclinic) [2010Gru]. The structural characteristics of these forms were listed by [2010Gru]. In the Co-rich region, CoAl ($B2$, CsCl-type cubic) occurs over a wide temperature and composition range (48-78 at.% Co). In the Fe-Al phase diagram [Massalski2], the solid solution based on the face-centered cubic (fcc) Fe is restricted by a γ loop. The solid solution based on the body-centered cubic (bcc) Fe exists in the disordered $A2$ and the ordered $B2$ and $D0_3$ forms. With increasing Al, four intermediate phases occur: ε ($D8_2$, Cu_5Zn_8-type cubic), $FeAl_2$ (triclinic), Fe_2Al_5 (orthorhombic), and Fe_4Al_{13} (monoclinic). In the Co-Fe system [Massalski2], a continuous fcc solid solution γ between fcc Fe and Co is stable over a wide temperature range. At 730 °C, the Fe-based bcc solid solution orders to a $B2$ structure via a second-order transition.

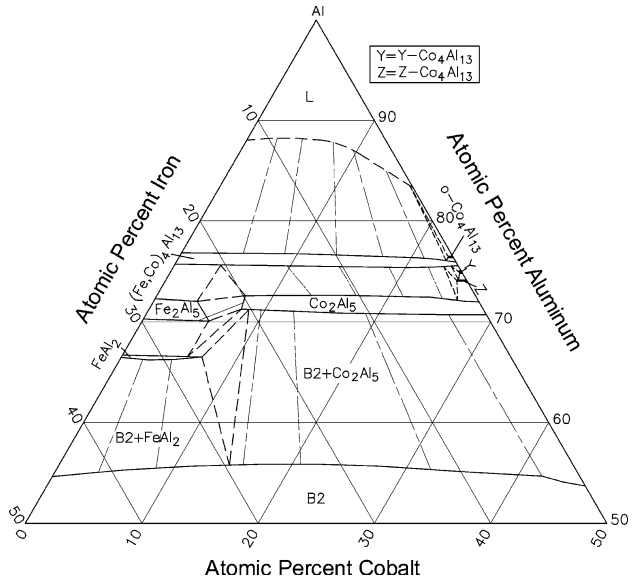

Fig. 1 Al-Co-Fe isothermal section at 1070 °C for Al-rich alloys [2010Gru]

Ternary Isothermal Section

With starting metals of 99.999% Al, 99.99% Co, and 99.99% Fe, [2010Gru] levitation-induction melted about 20 Al-rich ternary alloys. The alloys were annealed at 1070 °C for 264 h. The phase equilibria were studied with x-ray powder diffraction and scanning electron microscopy. The phase compositions were measured by energy dispersive x-ray analysis. The isothermal section constructed by [2010Gru] at 1070 °C for Al-rich alloys is shown in Fig. 1. FeAl and CoAl form a continuous $B2$ solid solution. Also, the isostructural compounds Fe_4Al_{13} and m-Co_4Al_{13} form a continuous monoclinic solid solution. The other three modifications of Co_4Al_{13} are also stable at this temperature [2010Gru]. Co_2Al_5 dissolves about 20 at.% Fe. [2010Gru] did a limited number of experiments at 800 °C and established the presence of Co_2Al_9 at this temperature. It dissolves up to ∼5 at.% Fe and forms a tie-triangle with the Al-rich liquid and $(Fe,Co)_4Al_{13}$.

References

1988Ray: G.V. Raynor and V.G. Rivlin, Al-Co-Fe, *Phase Equilibria in Iron Ternary Alloys*, Institute of Metals, London, 1988, p 71-81

1999Koz: T. Kozakai and T. Miyazaki, Phase Equilibria in the Fe-Al-Co Ternary System at 923 K, *Z. Metallkd.*, 1999, **90**(4), p 261-266

2002Rag: V. Raghavan, Al-Co-Fe (Aluminum-Cobalt-Iron), *J. Phase Equilb.*, 2002, **23**(5), p 434-436

2004Kam: N. Kamiya, T. Sakai, R. Kainuma, I. Ohnuma, and K. Ishida, Phase Separation of BCC Phase in the Co-Rich Portion of Co-Fe-Al System, *Intermetallics*, 2004, **12**, p 417-423

2004Koz: T. Kozakai, T. Shikama, T. Koyama, and M. Doi, Metastable Two-Phase Field ($A2 + B2$) in Co-Al-Fe and Co-Al Alloy Systems, *Mater. Sci. Forum*, 2004, **449-452**, p 61-64

2005Rag: V. Raghavan, Al-Co-Fe (Aluminum-Cobalt-Iron), *J. Phase Equilb. Diffus*., 2005, **26**(1), p 57-58

2006Koz: T. Kozakai, T. Koyama, and M. Doi, Phase Decomposition and Precipitation of Metastable *A*2 Phase in *B*2 Ordered Co-Al-Fe Alloys, *Z. Metallkd*., 2006, **97**(3), p 266-272

2008Rag: V. Raghavan, Al-Co-Fe (Aluminum-Cobalt-Iron), *J. Phase Equilib. Diffus*., 2008, **29**(6), p 515

2010Gru: B. Grushko, W. Kowalski, and M. Surowiec, On the Constitution of the Al-Co-Fe Alloy System, *J. Alloys Compd*., 2010, **491**, p L5-L7