

Al-Co-Ti (Aluminum-Cobalt-Titanium)

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The ASM compilation for this system [1995Vil] gave a partial liquidus projection and partial isothermal sections at 1300, 1200, 1100, 1000, 900, 800, 750, and 600 °C for Ti-rich alloys from the studies of [1967Tsu] and [1972Tsu] and a complete isothermal section at 800 °C from [1966Mar]. Recently, [2000Kai], [2001Ish], and [2002Ish1,2] presented phase relationships covering other composition ranges.

Binary Systems

The Al-Co phase diagram [1989McA] depicts several intermediate phases in the Al-rich part: Co_2Al_9 (monoclinic), $\text{Co}_4\text{Al}_{13}$ (monoclinic), CoAl_3 , and Co_2Al_5 ($D8_{11}$ -type hexagonal). The CsCl-type ($B2$) phase CoAl exhibits a wide range of homogeneity (~48 to 78.5 at.% Co). An updated version of the Al-Ti diagram appears in this issue. The Co-Ti phase diagram [Massalski2] has five intermediate phases: Co_3Ti (AuCu₃-type cubic), Co_2Ti (h) (C36-type hexagonal), Co_2Ti (c) (C15-type cubic), CoTi (CsCl-type cubic), and CoTi_2 (NiTi₂-type cubic).

Ternary Compounds

There are two established ternary compounds in this system: CoAl_2Ti ($\text{Mn}_{23}\text{Th}_6$ -type cubic) and Co_2AlTi (AlCu_2Mn , $L2_1$ -type cubic). [1995Vil] lists another ternary compound $\text{Co}_{21}\text{AlTi}_2$ (AuCu₃-type cubic) and two other compounds of unknown structure.

Isothermal Sections

With starting metals of 99.7% Al, 99.9% Co, and 99.5% Ti, [2001Ish] melted 26 Al-poor Co-Ti alloys in an arc furnace under Ar atm. The samples were given a final anneal at 1100, 1000, and 900 °C for 7, 14, and 21 days, respectively, and quenched in an ice-water mixture. The composition of the coexisting phases was determined by energy dispersive x-ray spectroscopy. The isothermal sections constructed by [2001Ish] at 1100, 1000, and 900 °C are redrawn in Fig. 1-3. At all these temperatures, the ternary phases Co_2AlTi and CoAl_2Ti are present over a range of composition. The phase boundaries between CoAl ($B2$) and Co_2AlTi ($L2_1$) and between Co_2AlTi and CoTi ($B2$) are partially second order (without a two-phase field) at 1100 °C. They are fully first order at 1000 and 900 °C (with an intervening two-phase region). A pseudobinary section along the CoAl - CoTi join in Fig. 4 [2002Ish2] shows a similar trend. The calculated critical temperature for the formation of Co_2AlTi ($L2_1$) is 2120 K (1847 °C), which lies in the liquid region [2002Ish1].

With starting metals of 99.99% Al, 99.9% Co, and 99.7% Ti, [2000Kai] melted a limited number of alloys in the composition range of Ti-(35-47) at.% Al-(0.5-12) at.% Co in an arc furnace under Ar atm. The alloys were given a final anneal at 1300, 1200, and 1000 °C for 24, 168, and 504 h, respectively, and quenched in ice-water mixture. The composition of the coexisting phases was determined by electron probe microanalysis. The partial isothermal sections determined by [2000Kai] at 1300, 1200, and 1000 °C

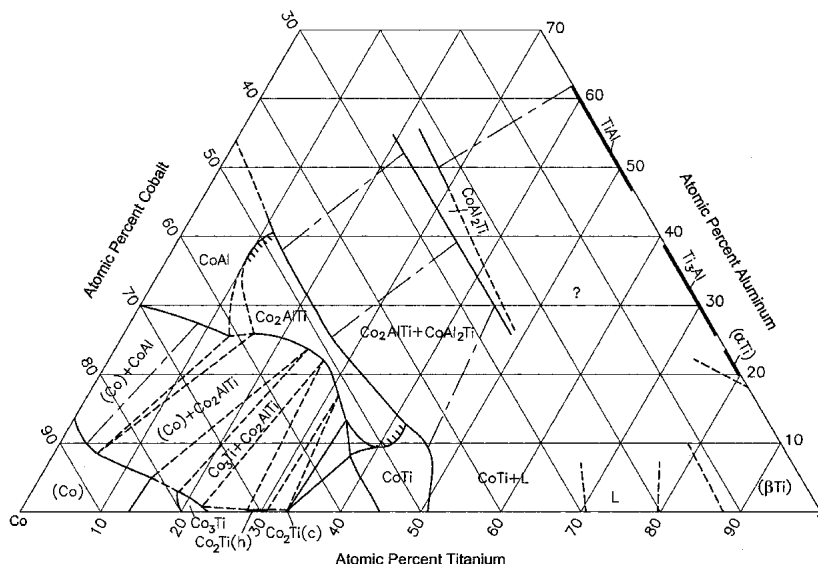


Fig. 1 Al-Co-Ti partial isothermal section at 1100 °C [2001Ish]

Section II: Phase Diagram Evaluations

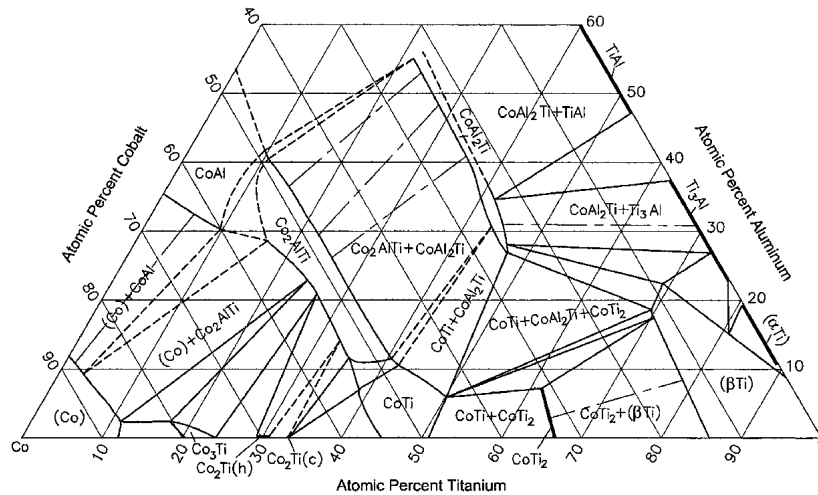


Fig. 2 Al-Co-Ti partial isothermal section at 1000 °C [2001Ish]

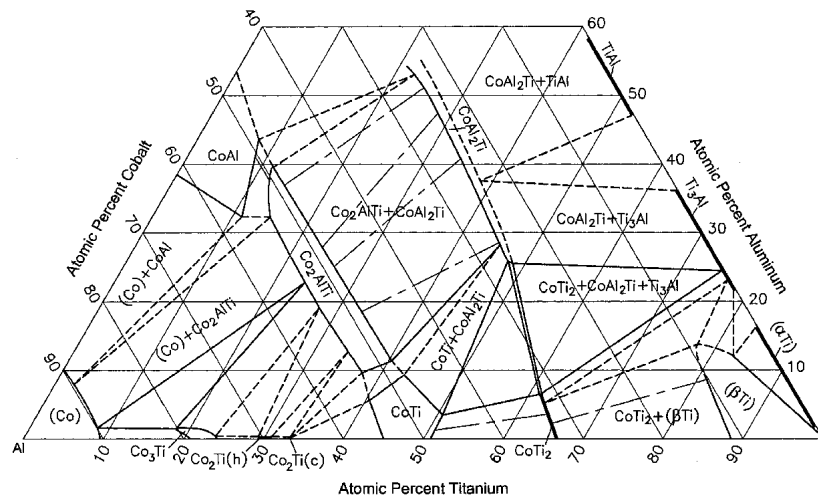


Fig. 3 Al-Co-Ti partial isothermal section at 900 °C [2001Ish]

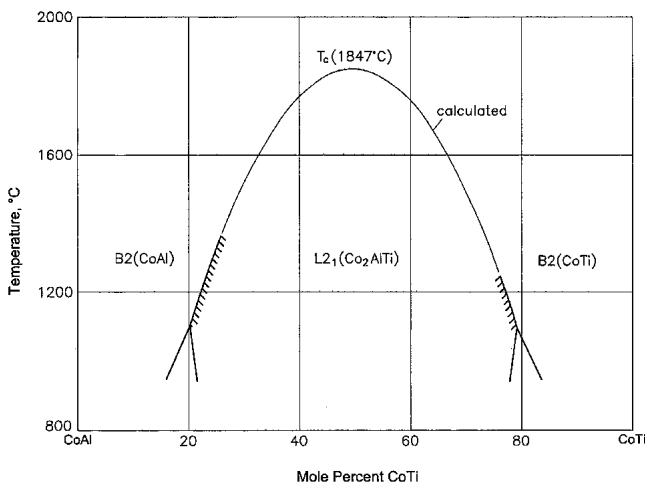


Fig. 4 Al-Co-Ti vertical section along the CoAl-CoTi join [2002Ish2]

are redrawn in Fig. 5. The Co partition coefficient $k^{\alpha\text{Ti}/\gamma}$ or $k^{\alpha 2/\gamma}$ is 0.65 at 1000 °C (characteristic of a γ stabilizer) and increases to 1.2 at 1300 °C, which indicates a reversal of the effect of Co. The Co coefficient $k^{\beta\text{Ti}/\gamma}$ is around 3-4 in this temperature range.

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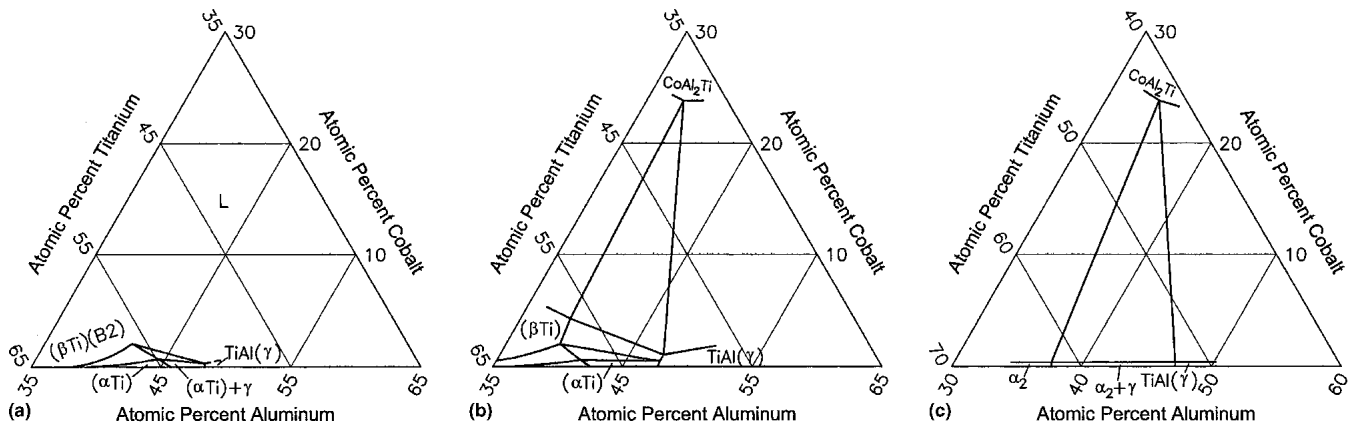


Fig. 5 Al-Co-Ti partial isothermal sections near the Ti-Al side at (a) 1300, (b) 1200, and (c) 1100 °C [2000Kai]

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