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Al-Co-U (Aluminum-Cobalt-Uranium)

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The early work on this system compiled by [1995Vil] included a liquidus projection, three isothermal sections at 800, 700, and 600 °C, three vertical sections along the AlCoU-CoU, AlCoU-Co_2U, and AlCoU-U joins from [1968Sam] and a pseudobinary section along the Al_2U-Co_2U join from [1964Pet]. Recently, [2005Noe] determined an isothermal section at 900 °C for the entire composition region, which depicts three new ternary compounds in addition to the ones known earlier.

Binary Systems

The Al-rich region of the Al-Co phase diagram was reinvestigated by [1996God]. Three modifications of Co_4Al_{13} occur in a narrow range of composition between 24 and 24.7 at.% Co [1996God]. The other intermediate phases are: Co_2Al_9 ($D8_d$-type monoclinic), $CoAl_3$($D0_{11}$, Fe_3C-type orthorhombic), Co_2Al_5 ($D8_{11}$-type hexagonal), and CoAl (48-78.5 at.% Co; $B2$, CsCl-type cubic). The Al-U phase diagram [Masssalski2] depicts three compounds: UAl_2 ($C15$, $MgCu_2$-type cubic), UAl_3 ($L1_2$, $AuCu_3$-type cubic), and UAl_4 ($D1_b$, UAl_4-type orthorhombic). The Co-U system [Massalski2] has six intermediate compounds: CoU_6 ($D2_c$, MnU_6-type tetragonal), CoU (B_a, CoU-type cubic), Co_2U ($C15$, $MgCu_2$-type cubic), Co_3U ($PuNi_3$-type rhombohedral), CoU_4, CoU_5 (CoU_5-type rhombohedral).

Ternary Compounds

In addition to the three previously-known ternary compounds, $UCo_{1+x}Al_{1-x}$ ($x \le 0.1$) (τ_4), U_2Co_2Al (τ_5), and $U_2Co_{3+x}Al_{1-x}$ ($x \le 0.1$) (τ_6), [2005Noe] found three more stable ternary compounds, $U_2Co_6Al_{19}$ (τ_1), $U_2Co_3Al_9$ (τ_2), and $U_3Co_{4+x}Al_{12-x}$ ($0.4 < x < 0.7$) (τ_3), plus a metastable compound $UCoAl_4$. The structural details of these compounds are listed in Table 1. The notations τ_1, τ_2, etc. given above in brackets correspond to the numbers 1, 2, etc. used by [2005Noe]. The metastable compound $UCoAl_4$ occurs only in cast samples and decomposes on annealing [2005Noe].

Table 1 Al-Co-U crystal structure and lattice parameter data [2005Noe]

Phase	Composition, at.%	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$U_2Co_6Al_{19}$ (τ_1)	70.4 Al 22.2 Co 7.4 U	*mC*108	*C*2/*m*	…	*a* = 1.44617 *b* = 1.20474 *c* = 0.82003 β = 103.9°
$U_2Co_3Al_9$ (τ_2)	64.3 Al 21.4 Co 14.3 U	*oC*56	*Cmcm*	$Y_2Co_3Ga_9$	*a* = 1.2789 *b* = 0.7477 *c* = 0.9258
$U_3Co_{4+x}Al_{12-x}$ (τ_3) ($0.4 < x < 0.7$)	61.1-59.5 Al 23.2-24.7 Co 15.8 U	*hP*?	*P*6$_3$/*mmc*	$Gd_3Ru_4Al_{12}$	*a* = 0.86518 *c* = 0.92620
$UCo_{1+x}Al_{1-x}$ (τ_4) ($x \le 0.1$)	33.3-30 Al 33.3-36.7 Co 33.3 U	*hP*9	*P*$\bar{6}$2*m*	ZrNiAl	*a* = 0.6677 *c* = 0.3965
U_2Co_2Al (τ_5)	20 Al 40 Co 40 U	*tP*10	*P*4/*mbm*	Mo_2FeB_2	*a* = 0.71061 *c* = 0.34641
$U_2Co_{3+x}Al_{1-x}$ (τ_6) ($x \le 0.1$)	16.7-15 Al 50-51.7 Co 33.3 U	*hP*12	*P*6$_3$/*mmc*	$MgZn_2$	*a* = 0.5120 *c* = 0.7692
$UCoAl_4$ (metastable)	66.7 Al 16.7 Co 16.7 U	*hP*?	*P*$\bar{6}$2*m*	…	*a* = 0.9161 *c* = 0.4114

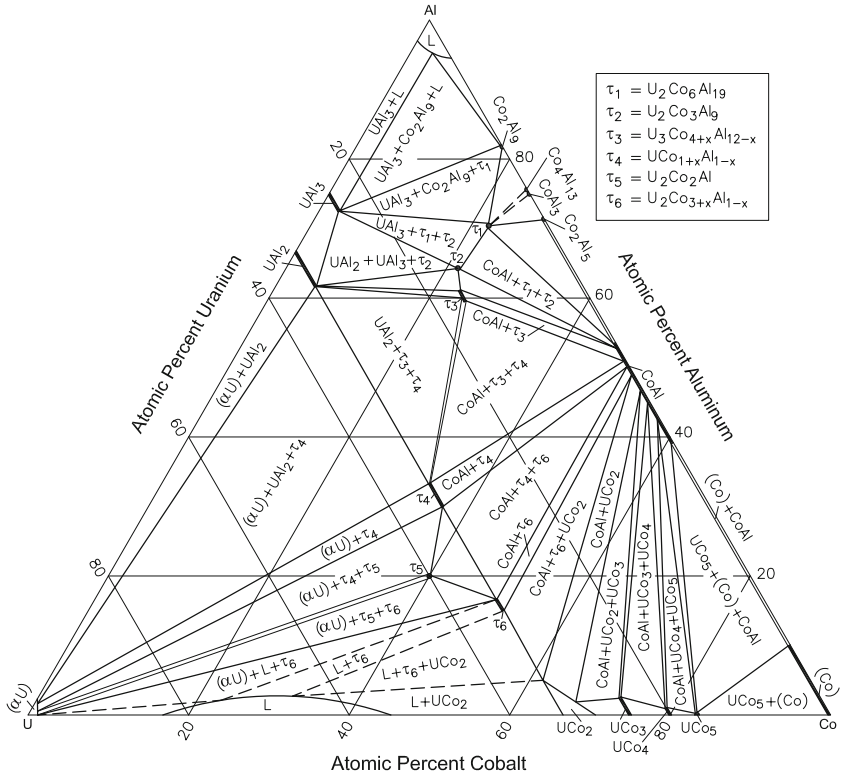

Fig. 1 Al-Co-U isothermal section at 900 °C [2005Noe]. Narrow two-phase regions are omitted

Ternary Isothermal Section

[2005Noe] vacuum-melted alloys in silica tubes and annealed them at 900 °C for 10 d. The phase equilibria were studied with x-ray powder diffraction and energy dispersive x-ray analysis attached to the scanning electron microscope. Fig. 1 shows the isothermal section at 900 °C constructed by [2005Noe] for the entire composition range. The six ternary compounds τ_1, τ_2, etc. are present at this temperature. The $MgNi_2$-type ternary compound UCoAl reported in earlier work was not found by [2005Noe]. The binary compound UCo_3 is not stable at this temperature, but was found by [2005Noe], possibly due to its stabilization by very small quantities of Al. UAl_2 and UAl_3 dissolve up to 5 and 2.5 at.% Co, which substitutes for Al. UCo_2, UCo_3, and UCo_4 dissolve up to 5, 2.5 and 1 at.% Al respectively, with Al substituting for Co. The Co-Al compounds show no solubility of U.

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