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Ag-Al-Ce (Silver-Aluminum-Cerium)

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Zhak et al. [1995Zha] determined an isothermal section for this system at 597 °C (870 K), which depicts six ternary compounds.

Binary Systems

The Ag-Al phase diagram [Massalski2] depicts three intermediate phases: Ag_3Al (20.5-29.8 at.% Al; denoted β, body-centered cubic; stable between 778 and ~600 °C), Ag_2Al (22.9-41.9 at.% Al; denoted δ, close-packed hexagonal), and μ (21-24 at.% Al, stable below 450 °C; *A*13, βMn-type cubic). The Ag-Ce phase diagram [Massalski2] depicts the following intermediate phases: Ag_4Ce, $Ag_{51}Ce_{14}$ ($Ag_{51}Gd_{14}$-type hexagonal), αAg_2Ce ($CeCu_2$-type orthorhombic), and AgCe (CsCl-type cubic). The Al-Ce phase diagram was recently reassessed thermodynamically by [2005Gao], using new experimental results as additional input. The intermediate phases in this system are: αCe_3Al ($D0_{19}$, Ni_3Sn-type hexagonal), βCe_3Al ($L1_2$, $AuCu_3$-type cubic), Ce_2Al (stable between 775 and 648 °C; Co_2Si-type orthorhombic?), CeAl (orthorhombic), $CeAl_2$ (*C*15, $MgCu_2$-type cubic), $\alpha CeAl_3$ (Ni_3Sn-type hexagonal), $\beta CeAl_3$ (stable between 1192 and 973 °C), $CeAl_4$ (or βCe_3Al_{11}, $D1_3$, Al-deficient Al_4Ba-type tetragonal), and αCe_3Al_{11} (αLa_3La_{11}-type orthorhombic).

Ternary Phases

The known ternary compounds of this system are listed in Table 1 from [1995Zha]. The compounds denoted τ_1 to τ_6 (labeled 1 to 6 by [1995Zha]) are present at 597 °C (870 K). The last-listed compound $CeAg_{3.1}Al_{7.9}$ was not found at 597 °C [1995Zha].

Isothermal Section

With starting metals of 99.9% Ag, 99.99% Al, and 99.5% Ce, [1995Zha] arc-melted under Ar atm 96 alloys with Ce content up to 50 at.%. The samples were annealed at 597 °C (870 K) for 700 h and quenched in water. Alloy compositions high in Ag or Ce were annealed for 1200 h. The phase equilibria were studied with x-ray powder diffraction. The isothermal section at 597 °C constructed by [1995Zha] is redrawn in Fig. 1, to

Table 1 Ag-Al-Ce crystal structure and lattice parameter data [1995Zha]

Phase	Composition, at.%	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$Ce(Ag_{0.52-0.58}Al_{0.48-0.42})_{11}(\tau_1)$	47.7-53.2 Ag 44-38.5 Al 8.3 Ce	*tI*48	$I4_1/amd$	$BaCd_{11}$	a = 1.10466 c = 0.71101
$Ce_{1.61}(Ag_{0.34-0.45}Al_{0.66-0.55})_{17}(\tau_2)$	31.1-41.1 Ag 60.3-50.3 Al 8.65 Ce	*hP*38	$P6_3/mmc$	$Ni_{17}Th_2$	a = 0.93742 c = 0.91525
$Ce_2(Ag_{0.52-0.66}Al_{0.48-0.34})_{17}(\tau_3)$	46.5-59.1 Ag 42.9-30.4 Al 10.5 Ce	*hR*19	$R\bar{3}m$	$Zn_{17}Th_2$	a = 0.94337 c = 1.36184
$Ce(Ag_{0.42-0.54}Al_{0.58-0.46})_5(\tau_4)$	35-45 Ag 48.3-38.3Al 16.7 Ce	*hP*6	*P*6/*mmm*	$CaCu_5$	a = 0.5550 c = 0.4419
$Ce(Ag_{0.15-0.19}Al_{0.85-0.81})_4(\tau_5)$	12-15.2 Ag 68-64.8 Al 20 Ce	*tI*10	*I*4/*mmm*	Al_4Ba	a = 0.43244 c = 1.1047
$CeAg_{0.9}Al_{2.1}(\tau_6)$	22.5 Ag 52.5 Al 25 Ce	*hR*12	$R\bar{3}m$	$PuNi_3$	a = 0.5644 c = 2.701
$CeAg_{3.1}Al_{7.9}$	25.83 Ag 65.83 Al 8.33 Ce	*cP*36	$Pm\bar{3}m$	$BaHg_{11}$	a = 0.8653

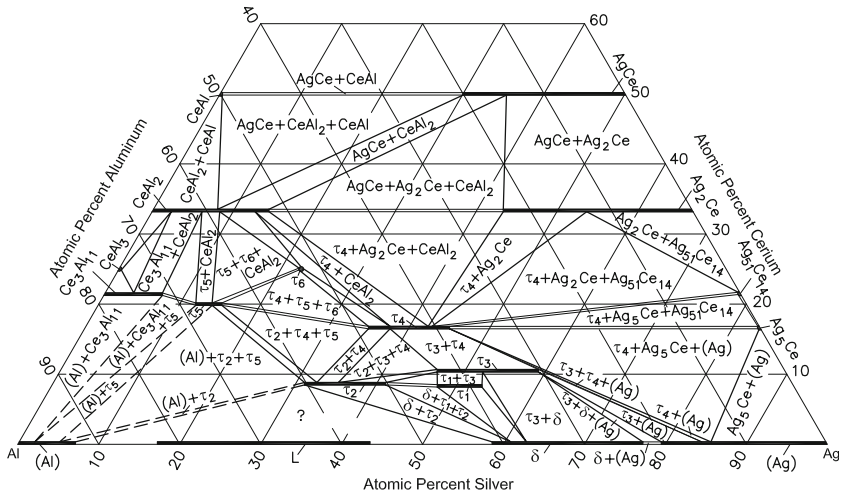

Fig. 1 Ag-Al-Ce isothermal section at 597 °C [1995Zha]

agree with the accepted binary data. A liquid phase present along the Al-Ag side was omitted by [1995Zha]. The compositions of the ternary phases shown in Fig. 1 are from the listed values of [1995Zha]. Following [1995Zha], Ag_5Ce (not Ag_4Ce) is indicated tentatively in Fig. 1. The low-temperature forms of AgCe and Ag_2Ce shown in Fig. 1 dissolve up to 20 and 23.3 at.% Al, respectively. $CeAl_2$ and αCe_3Al_{11} dissolve up to 14.3 and 7.1 at.% Ag, respectively [1995Zha].

References

1995Zha: O.V. Zhak, B.M. Stelmakhovich, and Yu.B. Kuzma, Phase Equilibria in the Ce-Ag-Al System in the Field Ranging from 0 to 0.5 Mole Fraction of Cerium, *Metally*,1995, (6), p 158-161 in Russian; TR: *Russ. Metall*., 1995, (6), p 123-126

2005Gao: M.C. Gao, N. Unlu, G.J. Shiflet, M. Mihalkovic, and M. Widom, Reassessment of Al-Ce and Al-Nd Binary Systems Supported by Critical Experiments and First-Principles Energy Calculations, *Metall. Mater. Trans. A*, 2005, **36A**, p 3269-3279