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Al-Er-Si (Aluminum-Erbium-Silicon)

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An isothermal section at 600 °C was determined for this ternary system by [2009Puk], which depicts seven ternary compounds of fixed stoichiometry.

Binary Systems

The Al-Er phase diagram [Massalski2, 2009Puk] depicts the following intermediate phases: $ErAl_3$ ($L1_2$, $AuCu_3$-type cubic), $ErAl_2$ ($C15$, $MgCu_2$-type cubic), ErAl (ErAl-type orthorhombic), Er_3Al_2 (Zr_3Al_2-type tetragonal), and Er_2Al ($C23$, Co_2Si-type orthorhombic). The Al-Si system is of the simple eutectic type with the eutectic at 577 °C and 12.2 at.% Si. The Er-Si phase diagram [Massalski2, 2009Puk] contains the following intermediate phases: $Er_3Si_{4.76}$ or Er_3Si_{5-x} (orthorhombic, $Amm2$), ErSi (B_f, CrB-type orthorhombic), Er_5Si_4 (Sm_5Ge_4-type orthorhombic), and Er_5Si_3 ($D8_8$, Mn_5Si_3-type hexagonal).

Ternary Compounds

Seven ternary compounds are stable in this system at 600 °C [2009Puk]. These are: $ErAl_{2.8}Si_{0.2}$ (denoted τ_1), $Er_2Al_3Si_2$ (τ_2), ErAlSi (τ_3), $\sim Er_5Al_6Si_4$ (τ_4), Er_2AlSi_2 (τ_5), $Er_2Al_{1.5}Si_{1.5}$ (τ_6), and Er_6Al_3Si (τ_7). The structural details of these compounds are listed in Table 1. The structure of $\sim Er_5Al_6Si_4$ (τ_4) is not known. Among the others, τ_2, τ_3, τ_5 and τ_6 were previously known. The other previously reported compounds $ErAl_2Si_2$ ($CaAl_2Si_2$-type), $ErAl_{0.25}Si_{0.75}$

Table 1 Al-Er-Si crystal structure and lattice parameter data [2009Puk]

Phase	Composition, at.%	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$ErAl_{2.8}Si_{0.2}$ (τ_1)	70 Al	*hP*24	$P6_3/mmc$	$PuAl_3$(HT)	a = 0.60295
	25 Er				c = 1.42308
	5 Si				
$Er_2Al_3Si_2$ (τ_2)	42.8 Al	*mS*14	$C2/m$	$Y_2Al_3Si_2$	a = 1.00711
	28.6 Er				b = 0.40104
	28.6 Si				c = 0.65561
					β = 100.675
ErAlSi (τ_3)	33.3 Al	*oS*12	*Cmcm*	YAlGe	a = 0.39738
	33.3 Er				b = 1.01616
	33.3 Si				c = 0.56542
$\sim Er_5Al_6Si_4$ (τ_4)	40 Al	…	…	…	…
	33.3 Er				
	26.7 Si				
Er_2AlSi_2 (τ_5)	20 Al	*oI*10	*Immm*	W_2CoB_2	a = 0.40215
	40 Er				b = 0.57078
	40 Si				c = 0.85441
$Er_2Al_{1.5}Si_{1.5}$ (τ_6)	30 Al	*tP*10	*P*4/*mbm*	Mo_2FeB_2	a = 0.68202
	40 Er				c = 0.42421
	30 Si				
Er_6Al_3Si (τ_7)	30 Al	*tI*80	*I*4/*mcm*	Tb_6Al_3Si	a = 1.1436
	60 Er				c = 1.4854
	10 Si				
$ErAl_2Si_2$	40 Al	*hP*5	$P\bar{3}m1$	$CaAl_2Si_2$	…
	20 Er				
	40 Si				
$ErAl_{0.25}Si_{0.75}$	12.5 Al	*cP*2	$Pm\bar{3}m$	CsCl	a = 0.3388
	50 Er				
	37.5 Si				
$ErAl_{0.5\text{-}0.75}Si_{0.5\text{-}0.25}$	25-37.5 Al	*oP*8	*Pnma*	FeB	a = 0.6910
	50 Er				b = 0.4223
	25-12.5 Si				c = 0.5395

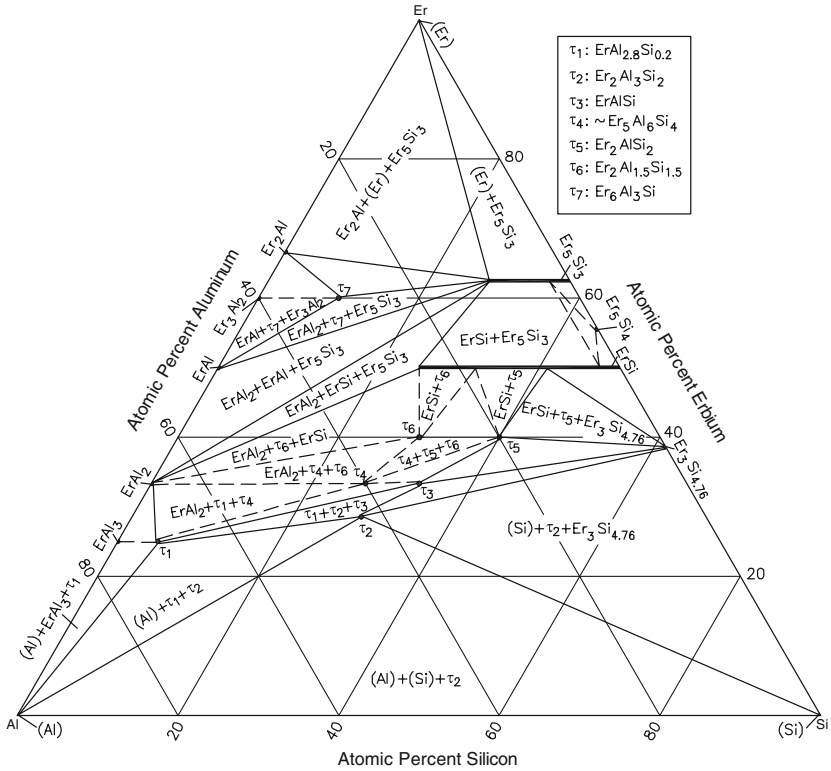

Fig. 1 Al-Er-Si isothermal section at 600 °C [2009Puk]. Narrow two-phase regions are omitted

(CsCl-type) and $ErAl_{0.5\text{-}0.75}Si_{0.5\text{-}0.25}$ (FeB-type) were not found at 600 °C by [2009Puk]. These are also listed in Table 1.

Isothermal Section

With starting metals of 99.99+% Al, 99.83+% Er and 99.999+% Si, [2009Puk] arc-melted under Ar atm 37 ternary alloys. The alloys were annealed at 600 °C for 720 h and quenched in water. The phase equilibria were studied with x-ray powder diffraction. The isothermal section at 600 °C constructed by [2009Puk] is shown in Fig. 1. The seven ternary compounds τ_1 through τ_7 are present essentially at fixed compositions. The binary phases Er_5Si_3 and ErSi dissolve 10 and 25 at.% Al respectively.

Reference

2009Puk: S. Pukas, W. Lasocha, and R. Gladyshevskii, Phase Equilibria in the Er-Al-Si System at 873 K, *CALPHAD*, 2009, **33**(1), p 23-26