JPEDAV (2009) 30:197–198
DOI: 10.1007/s11669-009-9489-y
1547-7037 ©ASM International

Al-Sc-Zn (Aluminum-Scandium-Zinc)

V. Raghavan

The phase equilibria of this system were studied by [1990Ikr], [1995Gan] and [2004Rok].

Binary Systems

The Al-Sc phase diagram [1999Cac, Massalski2] depicts the following intermediate compounds: $ScAl_3$ ($L1_2$, $AuCu_3$-type cubic), $ScAl_2$ ($C15$, $MgCu_2$-type cubic), ScAl ($B2$, CsCl-type cubic), and Sc_2Al ($B8_2$, Ni_2In-type hexagonal). In the Al-Zn system [Massalski2], solidification occurs through a eutectic reaction at 381 °C yielding (Zn) and (Al). On solidification, (Al) contains 67 at.% of dissolved Zn. At lower temperatures, this solid solution exhibits a miscibility gap, with a monotectoid reaction at 316 °C: $(Al)' \leftrightarrow (Al) + (Zn)$. The Sc-Zn system was investigated in the 40-100 at.% Zn range by [1997Pal]. The intermediate phases found are: $ScZn_{12}$ ($D2_b$, $ThMn_{12}$-type tetragonal), Sc_3Zn_{17} (Ru_3Be_{17}-type cubic), $Sc_{13}Zn_{58}$ ($Gd_{13}Cd_{58}$-type hexagonal), $ScZn_2$ ($C32$, AlB_2-type hexagonal), and ScZn ($B2$, CsCl-type cubic).

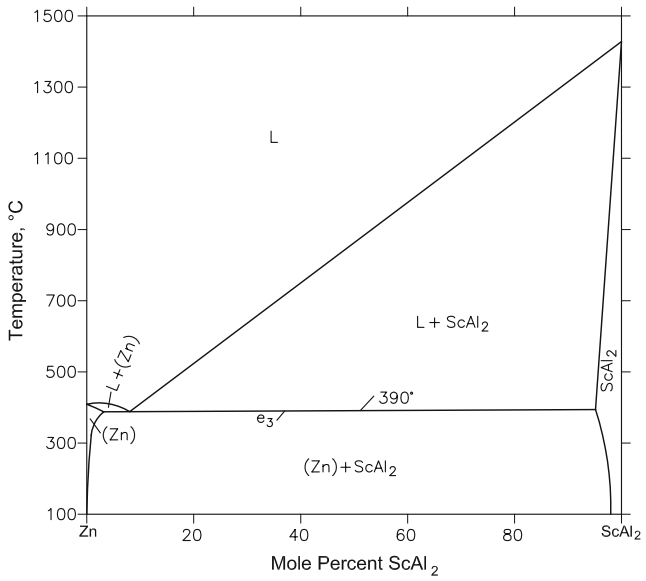

Fig. 1 Al-Sc-Zn pseudobinary section along the Zn-$ScAl_2$ join [1995Gan]

Ternary Phase Equilibria

The solidification characteristics in the Sc-lean region of this system were studied by [1995Gan]. Microstructural examination and differential thermal analysis were employed. The vertical section determined by [1995Gan] along the Zn-$ScAl_2$ join is shown in Fig. 1. This pseudobinary section is of the simple eutectic type, with the eutectic reaction e_3 at 390 °C and at the composition (at.%) 6.7Al-3.3Sc-90Zn. A liquidus projection in the Sc-lean region was also determined by [1995Gan]. This is shown in Fig. 2. Two four-phase invariant reactions occur in this region. The transition reaction U: $L + ScAl_2 \leftrightarrow ScAl_3 + (Zn)$ occurs at 370 °C and at 9.5Al-2.0Sc-88.5Zn (at.%). The final solidification is through the ternary eutectic reaction E: $L \leftrightarrow (Al) + (Zn) + ScAl_3$ at 367 °C and at 10.0Al-1.7Sc-88.3Zn (at.%).

According to [1995Gan], two isothermal sections at 500 and 300 °C were determined for this system by [1990Ikr]. The reference [1990Ikr] is not available to this reviewer. Recently, [2004Rok] determined an isothermal section for this system at 500 °C in the Al-rich region. With starting metals of 99.99% Al, 99.86% Sc, and 99.99% Zn, [2004Rok] melted alloys in a resistance furnace under a flux cover. The alloys were annealed at 500 °C for 50 h and quenched in water. The phase equilibria were studied with

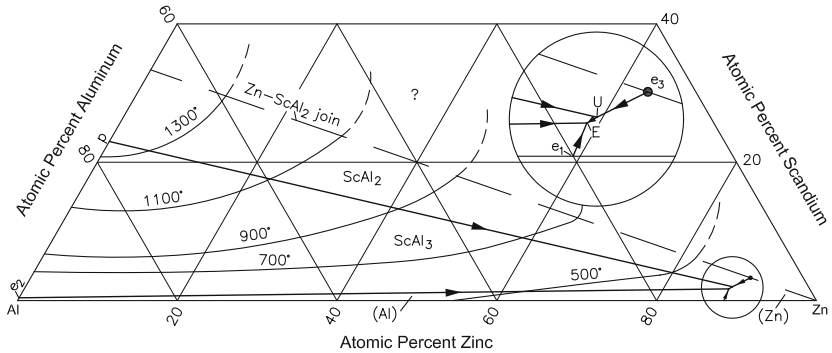

Fig. 2 Al-Sc-Zn liquidus projection in the Sc-lean region [1995Gan]

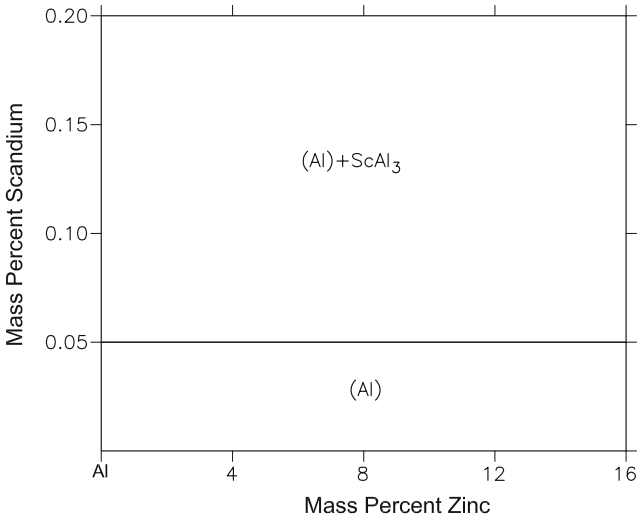

Fig. 3 Al-Sc-Zn isothermal section at 500 °C near the Al corner [2004Rok]

optical metallography, x-ray powder diffraction, electron probe microanalysis, and hardness measurements. The isothermal section constructed by [2004Rok] at 500 °C for the Al-rich region is shown in Fig. 3. The solubility of Sc in (Al) of 0.05 mass% remains unchanged in the presence of Zn up to 15 mass%. The solubility of Zn in $ScAl_3$ was determined to be ~5 mass%. Hardness measurements by [2004Rok] showed that, similar to Al-Sc binary alloys, the ternary alloys also exhibit substantial age hardening.

References

1990Ikr: A.Z. Ikromov, I.N. Ganiev, and V.V. Kinzhibalo, Diagram of Phase Equilibria in the Al-Zn-Sc System at 573 and 773 K, *Dokl. Akad. Nauk Rasplavy Tadzhikistan*, 1990, (6), p 391-392 (as quoted by [1995Gan])

1995Gan: I.N. Ganiev, A.Z. Ikromov, and V.G. Khudoiberdiev, Phase Diagram of Al-Zn-Al_2Sc System, *Metally*, 1995, (3), p 172-174, in Russian; TR: *Russ. Metall.*, 1995, (3), p 125-127

1997Pal: A. Palenzona and P. Manfrinetti, The Phase Diagram of the Sc-Zn System, *J. Alloys Compd.*, 1997, **247**, p 195-197

1999Cac: G. Cacciamani, P. Riani, B. Borzone, N. Parodi, A. Saccone, R. Ferro, A. Pisch, and R. Schmid-Fetzer, Thermodynamic Measurements and Assessment of the Al-Sc System, *Intermetallics*, 1999, **7**, p 101-108

2004Rok: L.L. Rokhlin, I.G. Korol'kova, and T.V. Dobatkina, Study of Phase Equilibria and Hardening in Al-rich Al-Zn-Sc Alloys During Aging, *Metally*, 2004, (4), p 89-92, in Russian; TR: *Russ. Metall.*, 2004, (4), p 376-379