Al-Hf-Zr (Aluminum-Hafnium-Zirconium)

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Recently, [2010Rok] determined the phase equilibria in Al-rich alloys of this ternary system between 600 and 400 °C.

Binary Systems

The Al-Hf system [1998Mur] depicts a number of intermediate phases: Hf_2Al (C16, CuAl_2 -type tetragonal), Hf_3Al_2 (Zr_3Al_2 -type tetragonal), Hf_4Al_3 (Zr_4Al_3 -type hexagonal), HfAl (B_f , CrB-type orthorhombic), Hf_2Al_3 (Zr_2Al_3 -type orthorhombic), HfAl_2 (C14, MgZn_2 -type hexagonal), βHfAl_3 ($D0_{23}$, ZrAl_3 -type tetragonal), and αHfAl_3 ($D0_{22}$, TiAl_3 -type tetragonal). The Al-Zr phase diagram [Massalski2] depicts the following intermediate phases: Al_3Zr ($D0_{23}$ -type tetragonal), Al_2Zr (C14, MgZn_2 -type hexagonal), Al_3Zr_2 (Al_3Zr_2 -type orthorhombic), AlZr (B_f , CrB-type orthorhombic), Al_4Zr_5 (Ga_4Ti_5 -type hexagonal), Al_3Zr_4 (Al_3Ir_4 -type hexagonal), Al_2Zr_3 (Al_2Zr_3 -type tetragonal), Al_3Zr_5 ($D8_m$, W_5Si_3 -type tetragonal), AlZr_2 ($B8_2$, Ni_2In -type hexagonal), and AlZr_3 ($L1_2$, AuCu_3 -type cubic). In the Hf-Zr system, continuous solid solutions form between βHf and βZr , and between αHf and αZr .

Phase Equilibria in Al-Rich Alloys

With starting metals of 99.99% Al, 99.8% Hf and 99.8% Zr, [2010Rok] melted about 30 binary and ternary alloys in

Fig. 1 Al-Hf-Zr solubility limit in (Al) at 600, 500 and 400 °C [2010Rok]

Fig. 2 Al-Hf-Zr isothermal section at 600 °C near Al corner [2010Rok]

a resistance furnace, by adding Al-Hf and Al-Zr master alloys to an Al melt. The alloys were given a final anneal at 600, 500 and 400 °C for 30, 100 and 100 h, respectively, followed by quenching in water. The phase equilibria were studied with electrical resistivity measurements, optical microscopy and scanning electron microscopy with energy dispersive x-ray analysis. The solubility limits of Hf and Zr in (Al) derived from electrical resistivity measurements at 600, 500 and 400 °C are shown in Fig. 1. The binary compounds αHfAl_3 and ZrAl_3 are in equilibrium with (Al). Figure 2 shows the isothermal section at the Al corner at 600 °C [2010Rok]. The sections at 500 and 400 °C (not shown here) are similar to the one in Fig. 2 [2010Rok].

References

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