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Technical Note

Preliminary Investigation of the System Ti-Mg

by J. W. Fredrickson

VERY little information is available in the literature concerning the solubility of magnesium in titanium. Aust and Pidgeon¹ report the solubility of titanium in magnesium to be 0.0025 pct at 650°C and 0.015 pct at 850°C. X-ray diffraction studies failed to detect any evidence of solid solubility. Based on the fact that the addition of titanium to magnesium increases the *c/a* ratio of magnesium, Busk² suggested that the Mg-Ti system, like the Mg-Zr, is a peritectic. Eisenreich³ reported the solubility of titanium in magnesium to be 0.003 pct at 655°C and 0.064 pct at 760°C. Removal of hydrogen from the melt increased the solubility of titanium to 0.115 pct at 800°C. Eisenreich proposes a peritectic-type diagram for the high magnesium side of the system. Recent work⁴ with Ti-Mg diffusion couples indicate that the solid solubility of titanium in magnesium is extremely small and that there is limited solid solubility of magnesium in titanium.

Experimental work on the Ti-Mg system is complicated by the fact that the boiling point of magnesium is considerably below the melting point of titanium. Consequently, the usual alloying methods are impractical. Alloying was accomplished in this investigation by sheath-rolling compressed compacts.⁵

The alloys were made from titanium sponge and high purity magnesium. Chemical analysis of the sponge showed 0.04 pct Mg, <0.005 pct Al, <0.001 pct Cu, 0.05 pct Fe, 0.022 pct Mn, <0.0025 pct Ni, 0.007 pct Si, <0.005 pct V, and <0.01 pct Zn.

All heat treating was conducted in a protective atmosphere by encapsulating the specimens in fused silica ampules under a partial pressure of helium. Equilibrium was achieved by holding the specimens at temperature for periods of 24 to 120 hr. The alloys were hot rolled, cold rolled, and annealed prior to solution heat treatment.

Fig. 1 shows the constitutional diagram obtained for the Ti-Mg system up to 1.5 pct Mg. Oxygen was known to be present in the alloys; therefore, it is necessary to consider the alloys as ternary rather than binary and the diagram should be viewed as a plot of a section through the Ti-Mg-O system. Other investigators⁶ have shown that the addition of oxy-

Fig. 1—Constitutional diagram obtained for the Ti-Mg system indicates that the addition of magnesium to titanium tends to stabilize the β phase.

gen to titanium stabilizes the α phase. The data presented in Fig. 1 indicate that the addition of magnesium to titanium tends to stabilize the β phase. Armour Research Foundation⁷ has shown that the addition of magnesium to zirconium lowers the α transus and is classified as a β stabilizer in that system.

Magnesium is soluble in solid titanium to the extent of at least 1.5 pct in both the α and β phases. No intermetallic compounds or magnesium-rich phases were observed either by light microscopy or X-ray diffraction. However, this does not negate the possibility that such phases exist at higher alloy concentrations.

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