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Al-C-Ta-Ti (Aluminum-Carbon-Tantalum-Titanium)

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[1983Sri] investigated the phase relationships in this quaternary system at 1100 °C and presented a perspective view of the composition tetrahedron and two isothermal sections at 9.1 and 25 at.% C, respectively.

Binary Systems

For brief descriptions of the Al-C, Al-Ti, and Ti-C phase diagrams, see the Al-C-Ti update in this issue. For descriptions of the Al-Ta and Ta-Ti diagrams, see [2005Rag]. The C-Ta phase diagram [1998Oka] depicts two intermediate phases with significant ranges of homogeneity: Ta_2C and the C-deficient TaC_{1-x} (*B*1, NaCl-type cubic).

Ternary Systems

The Al-C-Ti system is updated in this issue. See [2005Rag] for an update of the Al-Ta-Ti system. [1995Vil1] presented two isothermal sections at 1000 and 700 °C for the Al-C-Ta system. There are two ternary carbides in this system. Ta_2AlC (denoted *H*) has the Cr_2AlC-type hexagonal structure. $Ta_5Al_3C_{1-x}$ has the filled Mn_5Si_3-type hexagonal structure and appears only in the isothermal section at 1000 °C. For the C-Ta-Ti system, [1995Vil2] summarized a liquidus projection, an isothermal section at 1825 °C, and a pseudobinary section along the CTa_{1-x}-CTi_{1-x} join. The pseudobinary section shows complete solid solubility between the two monocarbides. No ternary phases were found in the system. Ta_2C dissolves about 28 at.% Ti at 1500 °C [1983Sri]. The solubility of C in the continuous bcc solution (βTi,Ta) is small.

Quaternary Phase Equilibria

[1983Sri] prepared quaternary alloy samples by arc-melting and sintering powder mixtures. The final annealing was done at 1100 °C, followed by quenching. The phase equilibria were studied mainly by x-ray powder diffraction. There are no quaternary compounds in this system [1983Sri]. The *H*-phases Ta_2AlC and Ti_2AlC form a continuous solid solution (denoted *H*). The lattice parameters vary from $a = 0.3075$ nm and $c = 1.383$ nm at Ta_2AlC to $a = 0.3056$ nm and $c = 1.362$ nm at Ti_2AlC [1983Sri]. The phase equilibria were plotted as a perspective view of the composition tetrahedron at 1100 °C and as two isothermal sections at 1100 °C for 9.1 and 25 at.% C, respectively. The isothermal sections are redrawn in Fig. 1 and 2. MC denotes the continuous solid solution between the C-deficient Ti and Ta monocarbides. MAl_3 denotes the continuous solution

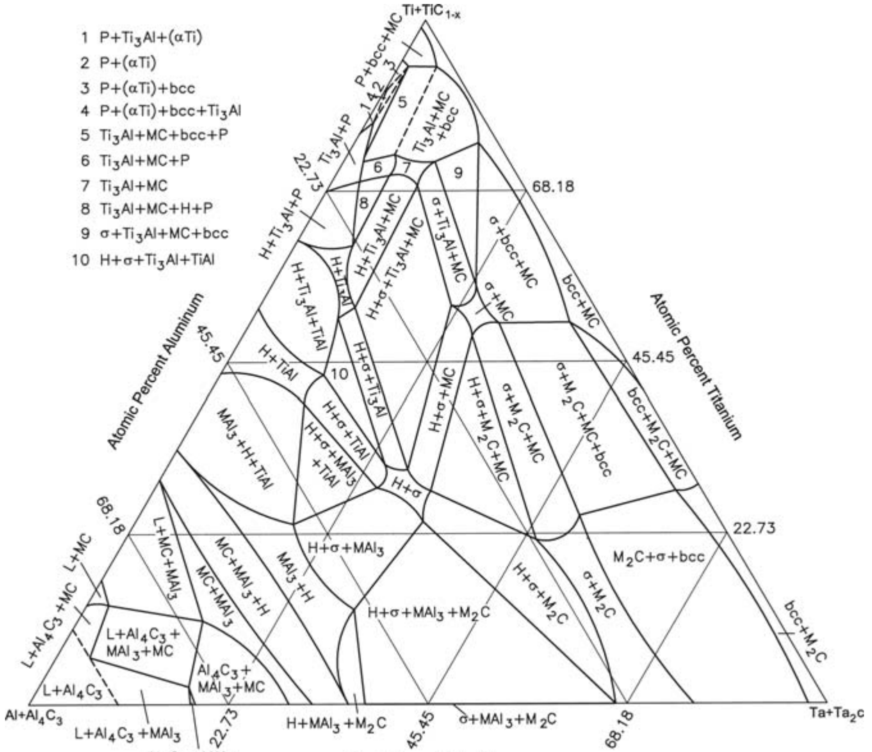

Fig. 1 Al-C-Ta-Ti isothermal section at 1100 °C and at 9.1 at.% C [1983Sri]

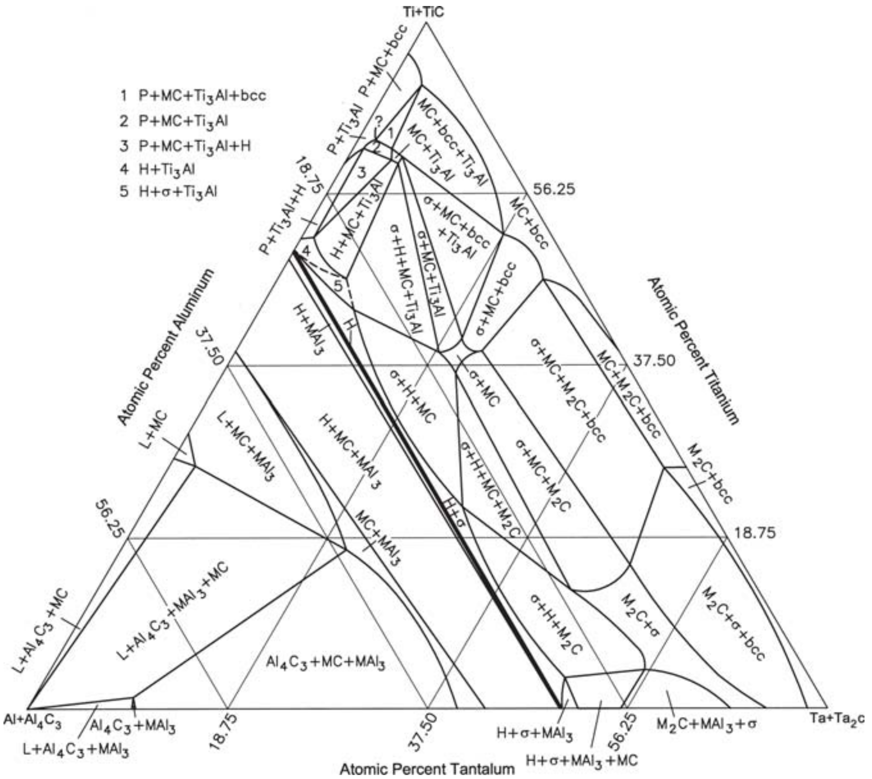

Fig. 2 Al-C-Ta-Ti isothermal section at 1100 °C and at 25 at.% C [1983Sri]

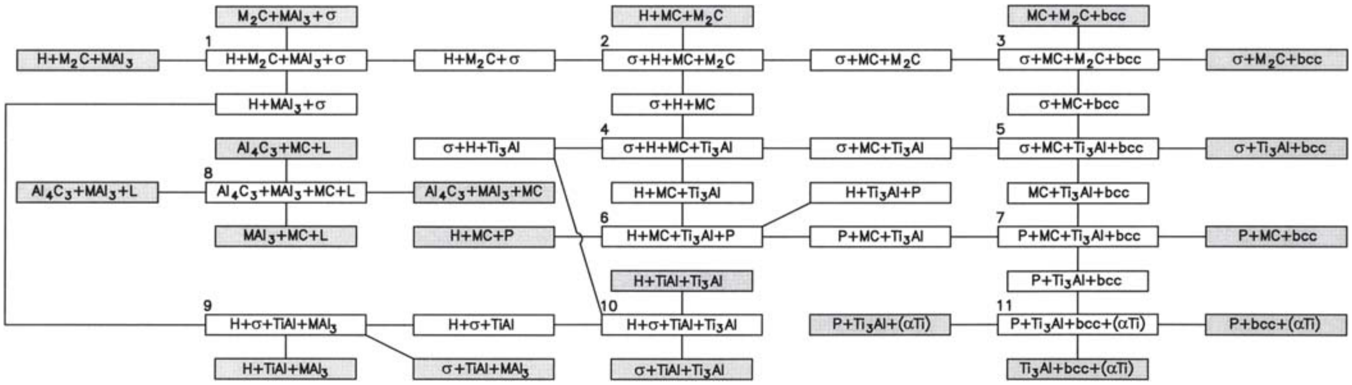

Fig. 3 Al-C-Ta-Ti network of three-phase and four-phase spaces at 1100 °C

between $TaAl_3$ and $TiAl_3$. M_2C stands for the solid solution $(Ta,Ti)_2C$. Figure 1 at 9.1 at.% C depicts sections of all the 11 four-phase tie-tetrahedra determined or deduced by [1983Sri]. The perovskite-type cubic phase Ti_3AlC is destabilized by small additions of Ta at 1100 °C. For the Al-Ta-Ti ternary, [1983Sri] used their own experimental results at 1100 °C. The homogeneity regions of the single-phase fields at 1100 °C reviewed in [2005Rag] are significantly different from those given by [1983Sri]. In the other three ternary systems, due to lack of data at the temperature of interest (1100 °C) or to the omission of Ti_5Al_{11} and $TiAl_2$ phases by [1983Sri], no correction is attempted along the sides of the triangular sections in Fig. 1 and 2. These sections may be considered tentative.

Figure 3 shows the linkage between three-phase and four-phase spaces at 1100 °C corresponding to the section in Fig. 1. The three-phase equilibria originating from the ternaries are shaded gray in Fig. 3.

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