1
Introduction

The reason why gamma TiAl has continued to attract so much attention from the research community including universities, publicly funded bodies, industrial manufactures, and end-product users is that it has a unique combination of mechanical properties when evaluated on a density-corrected basis. In particular, the elevated temperature properties of some alloys can be superior to those of superalloys.

Dimiduk [1] has assessed gamma TiAl with other aerospace structural materials and shown that new capabilities become available on account of its properties. The most important pay-offs involve

- high melting point;
- low density;
- high specific strengths and moduli;
- low diffusivity;
- good structural stability;
- good resistance against oxidation and corrosion;
- high ignition resistance (when compared with conventional titanium alloys).

Figure 1.1 shows how the specific modulus and specific strength of gamma TiAl alloys compare to other materials. As a result of these properties TiAl alloys could ultimately find use in a wide range of components in the automotive, aero-engine and power-plant turbine industries.

For a material to be ready for introduction, the whole production chain and supplier base, from material manufacture through processing and heat treatment must have achieved "readiness". This includes detailed knowledge of how component properties are related to alloy chemistry, microstructure, and processing technology. In addition, TiAl-specific component design and lifing methodologies need to be developed and give reliable predictions [2]. At the implementation stage no unforeseen technical problems concerning the processing route or component behavior, which may be very costly to remedy, should arise. In 1999, a time when fuel costs were relatively low compared to the current day, Austin [3] discussed how introduction of gamma would depend on economic viability. This was identified as the chief obstacle for the use of gamma, with marketplace factors dominating implementation decisions.

Gamma Titanium Aluminide Alloys: Science and Technology, First Edition. Fritz Appel, Jonathan David Heaton Paul, Michael Oehring.

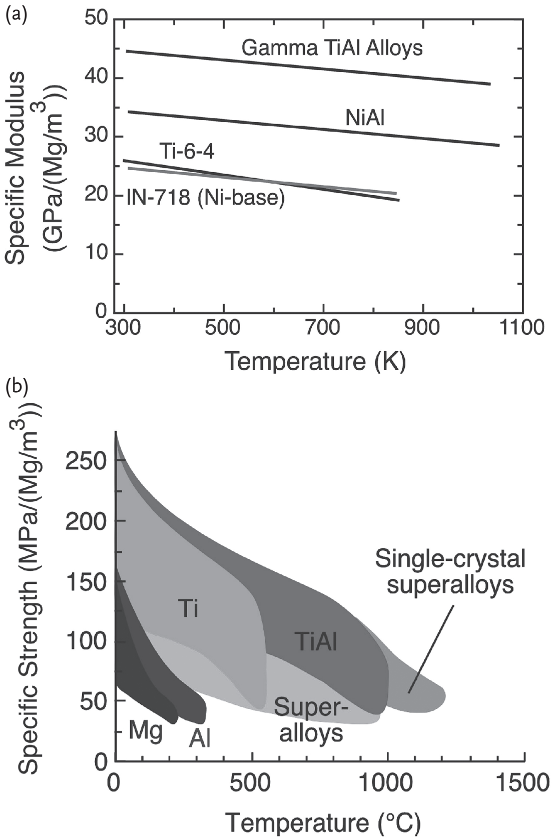

Figure 1.1 Graphs showing the (a) specific moduli and (b) specific strengths of TiAl and other structural materials, as a function of temperature [1]. The data indicates that TiAl compares favorably with the other materials. The data has been redrawn based on the original diagrams.

Due to its intermetallic nature, the complex constitution and microstructure, and the inherent brittleness, the physical metallurgy of TiAl alloys is very demanding. Nevertheless, we will attempt to discuss the broad literature that has been published over the last two decades concerning synthesis, processing and characterization. In our opinion, significant advances have been made, in particular General Electric has made public its intention [4, 5] to use gamma TiAl in its latest engine, the GEnx-1B (Figure 1.2), which best illustrates the present state that has been achieved in TiAl technology. Gamma TiAl has also been successfully introduced into at least one automotive series production, used in formula 1 racing engines, and a variety of components have been manufactured and successfully tested. In the following chapters we will present a comprehensive assessment of both the science and the related technology that has enabled TiAl to be used in the real world.

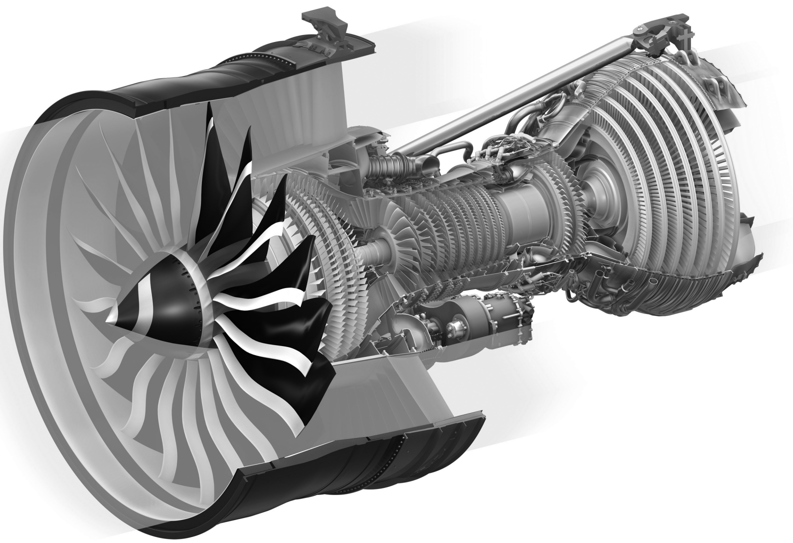

Figure 1.2 The General Electric GEnx-1B engine for the Boeing 787 Dreamliner. The blades in the last 2 stages of the low-pressure turbine in this engine are made from cast TiAl, making this engine the first to use TiAl in the real world. Photo courtesy of General Electric.

References

1. Dimiduk, D.M. (1999) *Mater. Sci. Eng.*, **A263**, 281.
2. Prihar, R.I. (2001) *Structural Intermetallics 2001* (eds K.J. Hemker, D.M. Dimiduk, H. Clemens, R. Darolia, H. Inui, J.M. Larsen, V.K. Sikka, M. Thomas, and J.D. Whittenberger), TMS, Warrendale, PA, p. 819.
3. Austin, C.M. (1999) *Curr. Opin. Solid State Mater. Sci.*, **4**, 239.
4. Weimer, M., and Kelly, T.J. Presented at the 3rd international workshop on γ-TiAl technologies, 29th to 31st May 2006, Bamberg, Germany.
5. Norris, G. (2006) Flight International Magazine.