Structure of TiAl / Ti_3Al-Interfaces

W. Wunderlich and F. Y. Hsu*

Institute für Metallkunde und Metallphysik, RWTH Aachen, D-52056 Aachen, Germany
** Gemeinschaftslabor für Elektronenmikroskopie, RWTH Aachen, D-52056 Aachen, Germany*

Introduction

Two-phase alloys on the base of TiAl48 with its lamellar α/γ_2-microstructure are in developement for high-temperature applications. The interface structure plays an important role for the plastic deformation of these alloys [1-5]. Certain arrangements of interface dislocations allow the emission of partial dislocations and subsequent forming of deformation twins. On the other hand HRTEM-investigations [4,5] showed that ledges are present at the α/γ_2-interface, which control the $\alpha \rightarrow \gamma_2$-transformations during cooling by their movement.

Experimental Results

The alloy TiAl47Cr1Si0.2 was analysed in detail in the as-cast-state. [1-3]. The weak-beam-dark-field (WBDF) analysis of the dislocation structures were performed on a Philips EM420 TEM with its great capability in tilting the specimens and imaging the Kikuchi-lines for easy distinguishing the different phases and zone-axis. Fig. 1 is a usefull tool for distinguishing the lamellae. Two of the six variants are crystallografic equivalent, therefore the variants c) and e) appear two times more frequent than d) and f). The WBDF-images (fig. 2) [2,3] clearly showed that both sides of the TiAl/Ti_3Al-interfaces contain misfit dislocations in networks of 60°-edge-dislocations. The number of dislocations is much higher than needed for compensating the misfit in lattice parameters. Hence, the dislocations are not in the state of their lowest thermodynamic energy and are are not strongly bonded to the interface.

In the HRTEM micrograph (fig. 3) taken on a JEOL 2000EXII with a point-to-point resolution of 0.23nm, a lattice plane is marked by a line, which ends at the interface. This is an evidence, that misfit-dislocations with Burgers vector components parallel to the interface plane are present which are not related to the ledges. The marked ledge at the interface may also contain a dislocation or may cause an elastic strain field, which will give contrast in the WBDF-images. Some additional contrast at the interface of the HRTEM-micrograph is probably due to inclined ledges in z-direction or distortions from dislocations with screw components.

Model

A threedimensional model of the interface was drawn (fig. 4) under the assumption, that both ledges and misfit dislocations are present and run parallel to the $<110>_{\alpha 2}$ or $<1120>_{\gamma}$ directions. Hence, structures of triangular shape will occur. For better clearance only misfit dislocations of one phase are drawn (Ti_3Al); the other phase (TiAl) contains additional ones. is drawn which are not related to each other in spacing or direction. This model helps for a better understanding of the interfacial structure. It shows that several interaction between ledges of two directions may take place. There are also two possibilties how misfit dislocations are arranged with respect to the ledges: They occur either combined with them or the ledges are situated half way between the misfit dislocations. For experimental proof and for more detailed refinement on an atomic scale, new experimental techniques like a combination of WBDF and HRTEM-methods have to be developed.

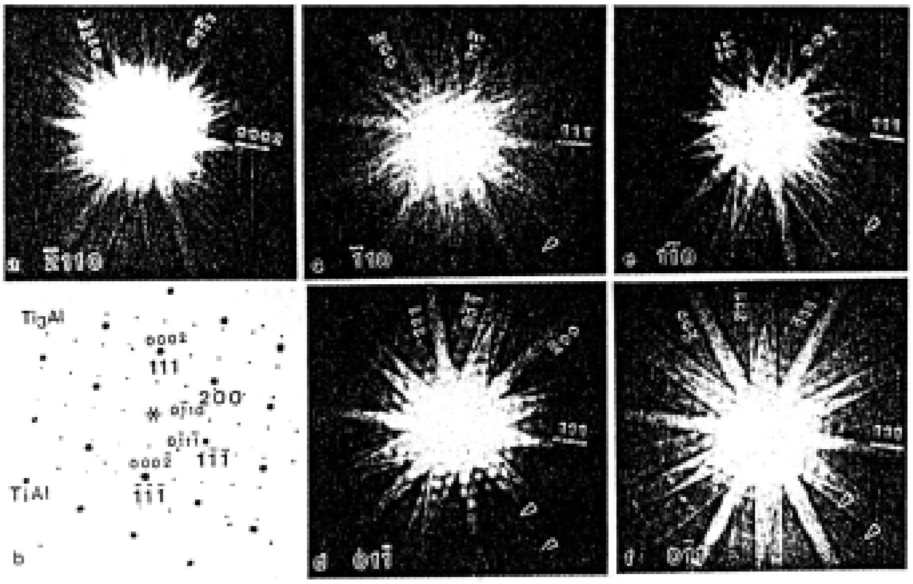

Fig. 1 Kikuchi pattern of Ti3Al and the four TiAl-variants

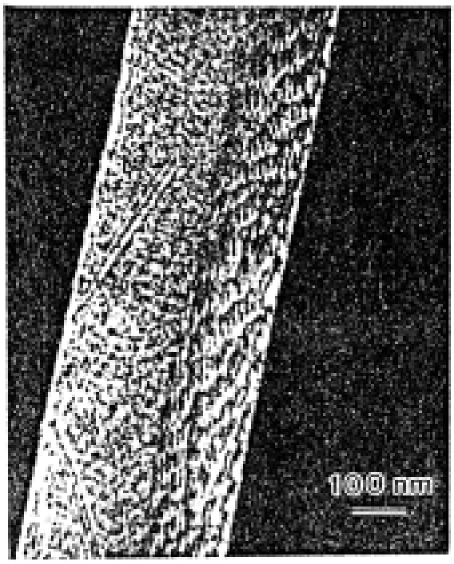

Fig. 2 WBDF-image of a α/γ_2-lamella

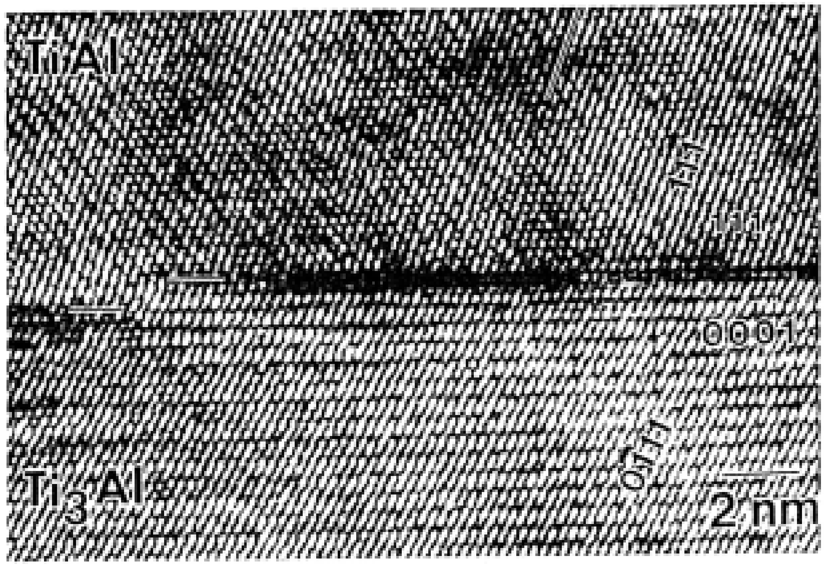

Fig. 3 HRTEM-image of the α/γ_2-interface

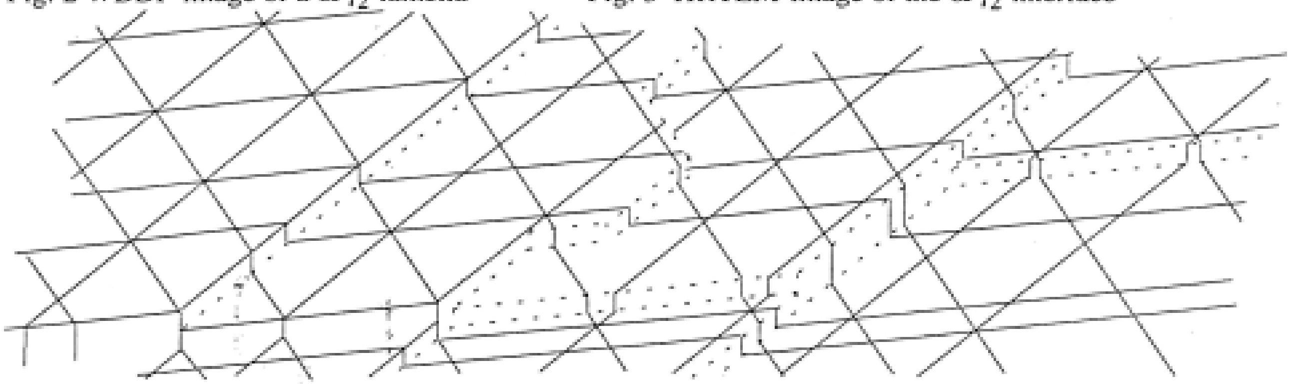

Fig. 4 Model of the arragement of ledges and dislocations at the α/γ_2-interface.

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