Microstructure of a massively transformed high Nb containing γ-TiAl based alloy

L. Cha[1], C. Scheu[2], G. Dehm[3,4], M. Rester[4] and H. Clemens[1]

1. Department Physical Metallurgy and Materials Testing, University of Leoben, A-8700 Leoben, Austria
2. Department of Chemistry and Biochemistry, Ludwig-Maximillians-University Munich, D-81377 Munich, Germany
3. Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, A-8700 Leoben, Austria
4. Department Materials Physics, University of Leoben, A-8700 Leoben, Austria

martin.rester@unileoben.ac.at

Keywords: titanium aluminide, transmission electron microscopy, lamellae formation, massive transformation

In this study a high Nb containing Ti-45Al-7.5Nb (composition in atomic percent) intermetallic alloy was investigated in order to get information about the initial stages of microstructure formation from the ordered α_2-Ti_3Al phase, since this determines the resulting mechanical behavior. The samples were heated above the α-transus temperature (~1295°C), annealed for 10 minutes in the single α-phase field and subsequently oil quenched to room temperature. Scanning electron microscope (SEM) investigations performed in back-scatter electron (BSE) mode exhibited a microstructure consisting of large supersaturated α_2-grains and approximately 10% irregular shaped γ_m (gamma massive, ordered TiAl) grains; a lamellar microstructure could not be detected by SEM (see Figure 1). Due to the limited spatial resolution of SEM, TEM was applied to study the microstructures especially at areas close to α_2/γ_m interfaces.

In the following, different types of γ modifications are distinguished by subscripts, e.g. γ_m indicates massively transformed γ, and γ_L denotes a γ-lath, which forms by diffusion. Some α_2 grains have a Blackburn orientation relationship (i.e. (111) <110] γ // (0001) <11-20> α_2) with the γ phase. The Blackburn orientation relationship is especially found for the diffusion formed lamellar microstructure consisting of alternating α_2 and γ_L laths but can also exist for a massive transformed γ_m and its matrix α_2 grain.

The results from TEM investigations are shown in Figure 2. The displayed TEM micrograph represents a α_2 matrix grain and an adjacent γ_m grain of irregular shape as well as fine lamellae. Combining the bright field image and the selected area diffraction (SAD) patterns taken in the vicinity of the α_2/γ_m interface, it can be concluded that the fine lamellae are γ laths (γ_L) which occur within the α_2 grain. The TEM analysis indicates that the γ_L laths may have formed after the massively transformed γ_m grain, since no grain boundary is detected between γ_L and γ_m. We believe that this process is triggered locally by the heat released from the γ_m grain during massive transformation, forming a local hot spot. Further TEM studies are under progress to analyze the chemistry at the diffusionless formed α_2/γ_m interface and the diffusion assisted interface α_2/γ_L.

W. Grogger, F. Hofer, P. Pölt (Eds.): MC2009, Vol. 3: Materials Science,
DOI: 10.3217/978-3-85125-062-6-488 , © Verlag der TU Graz 2009

1. This work was financially supported by the FWF (Fonds zur Förderung der wissenschaftlichen Forschung) through Project P20709-N20.

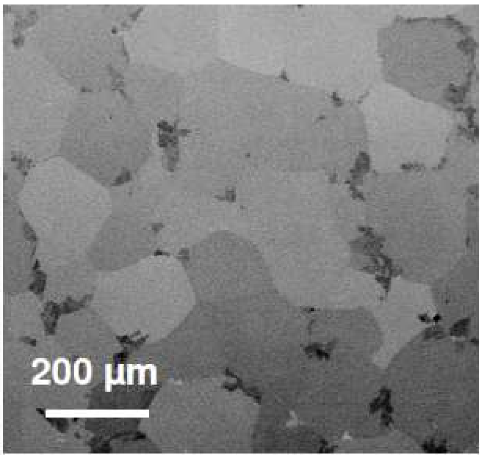

Figure 1. SEM image of Ti-45Al-7.5Nb taken in back-scatter electron (BSE) mode. The large grains consist of supersaturated α_2-phase, the dark appearing phase at the grain boundary and triple junctions is γ_m.

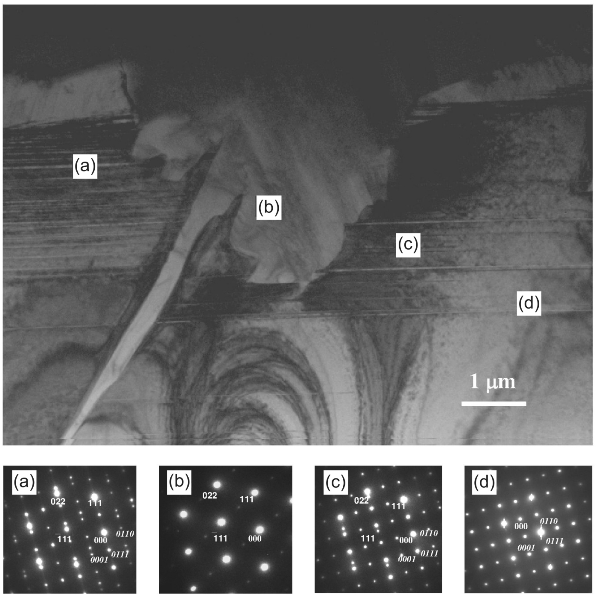

Figure 2. BF image of a α_2-grain and the joining γ_m phase. The SAD patterns taken in $[2\text{-}1\text{-}10]_{\alpha 2}//\langle 110\rangle_\gamma$ direction are from regions (a)-(d). The structures denoted (a)-(d) are $(\alpha_2+\gamma_L)$ lamellae, massive transformed γ_m, $(\alpha_2+\gamma_L)$ lamellae and pure α_2, respectively. In the SAD patterns the reflections labeled with 4 indices belong to the hexagonal α_2-Ti_3Al phase, those with 3 indices to the cubic γ-TiAl phase which has either formed during massive transformation (γ_m) or as a lath by diffusion (γ_L).

W. Grogger, F. Hofer, P. Pölt (Eds.): MC2009, Vol. 3: Materials Science,
DOI: 10.3217/978-3-85125-062-6-488 , © Verlag der TU Graz 2009