

High Temperature Microstructural Stability of Si₃N₄ in TiAl Alloys

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The ordered L1₀ intermetallic γ -TiAl has attracted an enormous interests for high temperature structural applications because of its high specific strength and melting point. However, major obstacles restricting its use are poor ductility at room temperature, low strength and poor oxidation resistance at high temperatures. These drawbacks can be overcome by reinforcing the matrix with second particles, including Si₃N₄. However, the compatibility of the second phase is essential for practical applications, because the chemical, physical, and mechanical properties of the TiAl alloys can be affected significantly. The aim of this study is to study the high-temperature microstructural stability of the Si₃N₄ dispersoids in the TiAl alloys during sintering and heating at high temperatures.

In this study, Ti-50 at.% Al alloys with (3 and 10)wt.% Si₃N₄ particles were prepared by a mechanical alloying-spark plasma sintering (MA-SPS) method. The starting powders were Ti (< 150 μ m, 99.9% pure), Al (100-180 μ m, 99.9% pure) and α -Si₃N₄ (<50 μ m, >99.0% pure). For MA, Ti and Al were mixed using a shake mixer for 10 min and subsequently milled in a planetary mill for 140 hr under 150 kPa of Ar + 1%N₂ atmosphere. Dilute nitrogen was added to help the MA of elemental powders. Onto the MA'ed Ti-Al powders, Si₃N₄ was added in

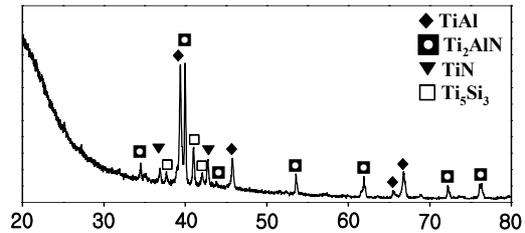


Fig. 2. Step scanned XRD of TiAl-10wt.%Si₃N₄ after heat treating at 1373 K for 100 hr.

predetermined ratios, mixed again in a shake mixer for 12 hr, compacted uniaxially, and sintered by discharging plasma at 1373 K for 10 min under a pressure of 57 MPa in a SPS apparatus. The specimens were ground to a 1000 grit finish, ultrasonically cleaned in acetone, and heat treated at 1373 K under an atmospheric air for 100 hr in a furnace. The specimens were inspected by electron probe microanalyses (EPMA), and X-ray diffraction (XRD) techniques.

The matrix consisted primarily of TiAl, Ti₂AlN, TiN and Ti₅Si₃. The matrix consisted primarily of TiAl, Ti₂AlN, TiN and Ti₅Si₃. Si₃N₄ was unstable in the matrix to be decomposed to form Ti₂AlN, TiN, Ti₅Si₃ and a reaction

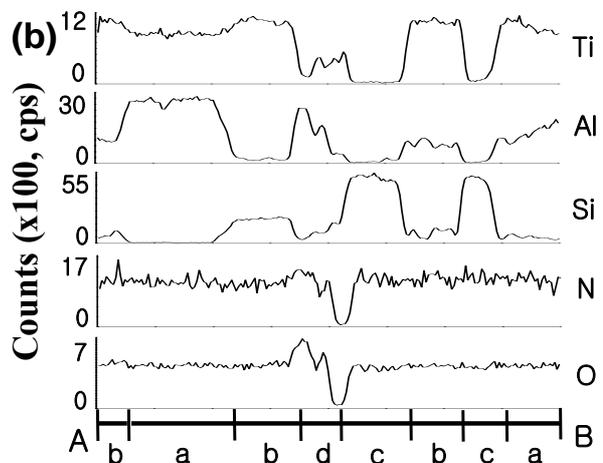
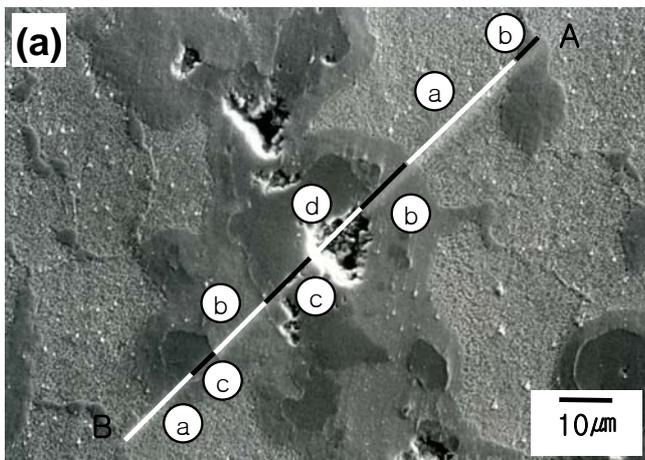


Fig. 1. (a) EPMA cross-sectional image (etched), and (b) line profiles across A-B of TiAl-10wt.%Si₃N₄. a(white area) = TiAl matrix, b(grey area) = Ti₅Si₃, c(dark area) = initially added Si₃N₄ dispersoids, d= porous area.

layer during sintering and heat treatment at 1373 K. Silicon nitride in the TiAl-Si₃N₄ alloys continuously reacted with Ti to form Ti₅Si₃, and decomposed to form nitrides during sintering and the subsequent heating stage. The chemical incompatibility of Si₃N₄ with the matrix led to the formation of a reaction layer and voids in the periphery of Si₃N₄.

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