

Investigation of ordering and disordering of β/β_0 -phase in γ -TiAl alloys by neutron diffraction

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γ -TiAl alloys are attractive materials for structural high temperature applications due to their high specific tensile and creep strength. Nevertheless, their wider application is still hampered by the difficulties involved with TiAl processing and by the limited understanding how ductility and damage tolerance of the material during service is influenced by microstructure and phase constituents. For both aspects the body centered cubic β phase and its ordered low temperature β_0 variant are of importance. β phase improves hot workability of the γ -TiAl alloys, while the ordered β_0 phase is said to embrittle the material at service temperature and to reduce the creep strength. A better knowledge about the ordering and disordering process of β/β_0 phase will widen the possibilities for a better microstructural control.

Neutron and synchrotron radiation are widely used for performing in-situ measurements during heating and cooling in γ -TiAl alloys. While synchrotron radiation is well suited for relatively fast measurements of the phase constitution over wide temperature ranges, the neutron measurements have an advantage for the investigation of the β/β_0 phase ordering/disordering transformation. This is due to the fact that the scattering length of Ti and Al are almost equal in modulus but of opposite sign. This difference causes a high intensity of the ordered β_0 super-lattice reflections by neutrons in comparison to the fundamental reflections of ordered and disordered phase. In-situ neutron measurements on this order/disorder transition using the materials science diffractometer STRESS-SPEC at FRM II in Garching, Germany have been performed in the current study. Three binary and 5 ternary γ -TiAl alloys with nominal composition Ti-(39, 42, 45 at %)Al and Ti-42Al-2X, (X=Fe, Cr, Mo, Nb, Ta) were investigated. For the heat treatments a vacuum high temperature furnace was used. The samples were stepwise heated in a temperature range from 1100°C up to 1440°C. A heating ramp of 20 °C/min was used. Diffraction patterns were extracted using the program STeCa and quantitative phase analysis was performed in MAUD software. As a result three samples, with 2 at.% of Fe, Mo and Cr, show a superlattice β_0 -(100) peak in the three phase field $\beta_0+\alpha_2+\gamma$. Five samples including all binary Ti-Al based compositions show no β_0 phase at all. At temperatures above 1300 °C no ordered β_0 phase appeared even in the high temperature two phase region $\beta+\alpha$. Mo additions shift the $\beta_0\leftrightarrow\beta$ transformation to higher temperatures. In the talk more results and details of neutron measurements will be shown.

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