	Experiment title: <i>In-situ phase identification and transformation at the reaction between Ti-Al and in TiAl based alloys containing Gd</i>	Experiment number: MA - 736
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Abstract:

Mixtures of 47-Al and 53-Ti powders (atomic %) have been consolidated using back pressure equal channel angular pressing starting with both raw and ball milled powders. We present in-situ synchrotron high-energy X-ray diffraction studies with continuous Rietveld analysis obtained upon a heating ramp from 300 K to 1075 K performed after the consolidation process. Initial phase distributions (Figure 1) contain all intermetallic compounds of this system except Al, with distribution maxima in the outer regions of the concentrations (α -Ti, TiAl₃). Upon annealing, we followed unprecedentedly in detail the phase evolution and lattice parameter changes due to chemical segregation which is in favor for the more equilibrated phases such as γ -TiAl, α_2 -Ti₃Al and TiAl₂. An initial δ -TiH₂ content with a phase transition at about 625 K upon heating created an intermediate β -Ti phase which played an important role in the reaction chain and gradually transformed into the final products.

Summary and conclusions:

- (1) In-situ synchrotron high energy X-ray diffraction was used to study the evolution of phases during heating and cooling in two Ti-Al alloys consolidated from ball milled and mechanically stir-mixed powders, respectively, by back pressure equal channel angular pressing at 903 K. Both powders consisted of just Al and Ti phases before consolidation although the phases were finer and better mixed in the ball milled powder.
- (2) During consolidation, the original Al and Ti phases in the powders reacted to form various intermetallic compounds as well as α -Ti(Al) solid solution while all Al had been consumed. However, the phases were dominantly out of equilibrium with little formation of the equilibrium γ -TiAl especially in the coarser raw material after the consolidation.
- (3) During the in-situ heating and cooling, the more equilibrium phases γ -TiAl, TiAl₂ and Ti₃Al gained at the expense of the highly non-equilibrium TiAl₃ and α -Ti. However, the march towards equilibrium was more significant in the raw sample, with a lower transformation starting temperature, than in the milled sample, leading to a phase structure closer to equilibrium despite an initially less equilibrium one
- (4) In addition, there was the δ -TiH₂ phase in both consolidated materials due to absorption of H. This hydride phase reacted with α -Ti to form β -Ti at \sim 630 K. The transformation from α to β continued above 630 K with a decrease in the H content in β which caused a reduction of the lattice parameter. The transformation was reversed to that of β to α on cooling until all the β was consumed.

(5) The evolution of lattice parameters and their ratios bespeak the chemical order of the phases. This allows to follow in detail the behavior of the H concentration in the β -Ti phase, the solution of Al in the α -Ti phase as well as the order / disorder of α_2 -Ti₃Al and γ -TiAl, leading to deeper insight into the kinetics of the multiphase system.

Publication:

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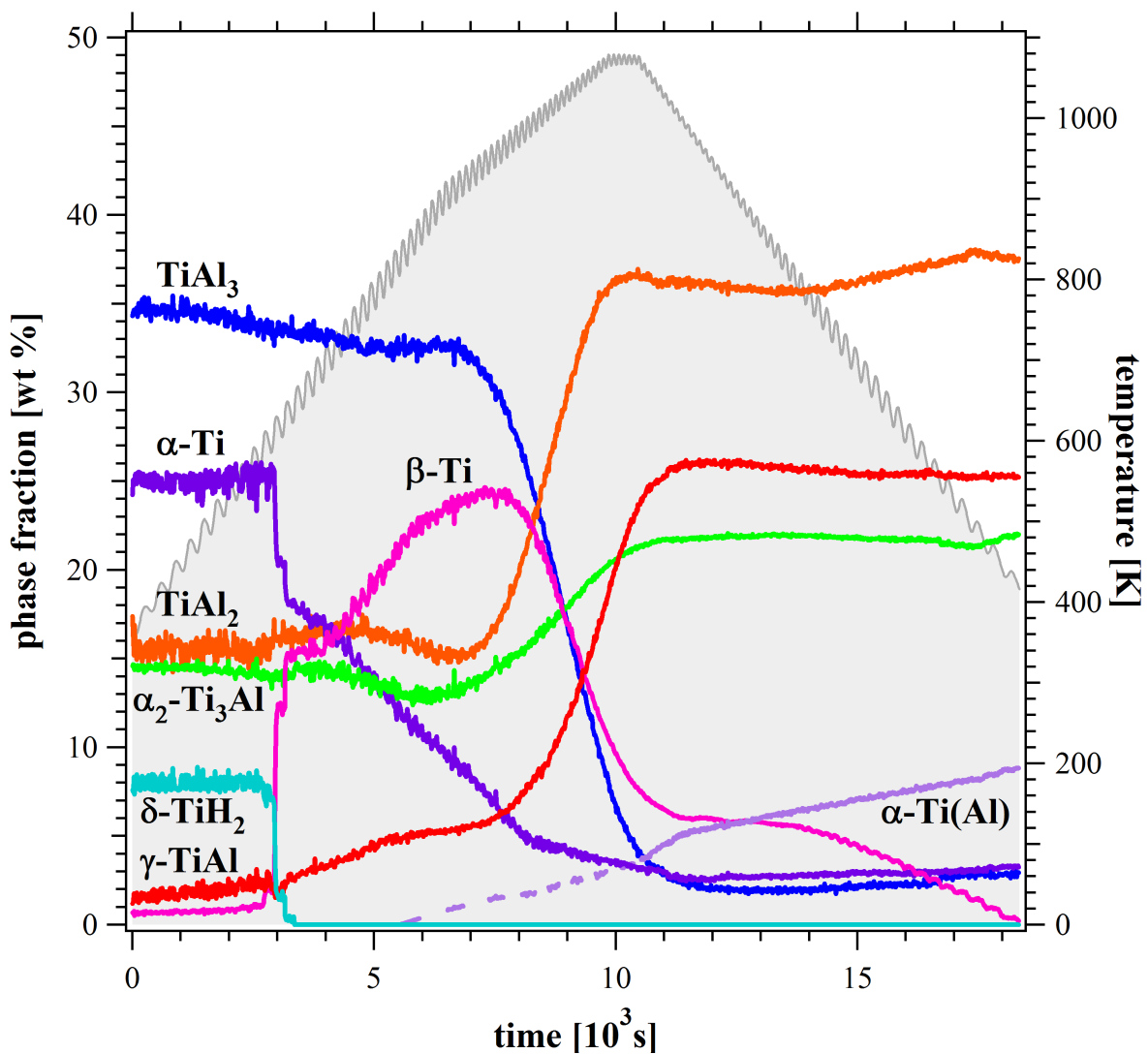


Figure 1: The weight fractions of the detected phases as a function of time (temperature) during the in-situ scan as obtained by Rietveld refinement analysis.

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