INTERDISCIPLINARY CENTRE FOR ADVANCED MATERIALS SIMULATION

ICAMS Special Seminar

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Dr. Florian Pyczak

Institute of Materials Research
Helmholtz-Zentrum Geesthacht, Germany

γ-TiAl-alloys - some not so well known aspects of a well known system

γ-TiAl alloys now replace heavier nickel-base superalloys as material for some turbine blade applications in jet aero engines up to service temperatures of 750 °C. This is due to their lower density, higher specific strength and better creep resistance in that temperature regime. Nevertheless, there is an ongoing research to make γ-TiAl alloys more damage tolerant, easier to process and more creep resistant. To achieve this different alloying elements are added. Niobium can improve the creep as well as the oxidation resistance. Carbon additions are potential means to improve the high temperature strength of γ-TiAl alloys. Unfortunately, when deviating from the binary Ti-Al system by adding increasing amounts of alloying elements the phase constitution changes significantly and phenomena unknown in the binary system occur.

The paper will present investigations about the morphological stability of carbides in γ-TiAl alloys. Investigations by transmission electron microscopy reveal that contrary to the typical coarsening of precipitate particles to achieve a better balance between energy gain scaling with volume and interfacial energy scaling with surface area these carbide precipitates decompose in smaller sub-particles. As it can be excluded that this is part of a dissolution process of these carbides the most probable explanation is a favourable contribution of elastic interaction energy between the carbide sub particles. The transmission electron investigations give insight into details of the process as a local re-orientation of the matrix regions between the sub particles. The orthorhombic O-phase in a Ti-42Al-8.5Nb alloy is investigated clearing its structure and transformation history as well as its local arrangement in the microstructure. The O-phase was until now not reported in this composition range and only a combination of in-situ high energy X-ray diffraction and transmission electron microscopy could give a deeper insight. Nevertheless, not all aspects are cleared yet. Especially the question if O-phase is stable in the composition and temperature regime under investigation or is stabilized by local stress states could not be decided conclusively. It is noteworthy that even in the binary system some features are still debated. In literature no agreement whether the β-phase at high temperature is an unordered solid solution with bcc structure or shows an ordering of titanium and aluminum atoms exhibiting a B2 structure is achieved. By measurements at temperature using neutron diffraction which is especially sensitive to ordering of the crystal structure under investigation it is shown that a number of alloying elements promote the ordering to the B2 structure but that the unordered bcc β-phase is present in the binary system contrary to what is reported in some phase diagrams.