ESRF	Experiment title: **In situ study of the coarsening of nickel based single crystal γ ' precipitate: evolution of the volume fraction and of the lattice parameter mismatch**	**Experiment number:** HS 550
Beamline: ID15A	**Date of Experiment:** from: 2 april 98 to: 7 april 98	**Date of Report:** 26/2/99
Shifts:	**Local contact(s):** A. Royer	*Received at ESRF :* 24 FEV. 1999

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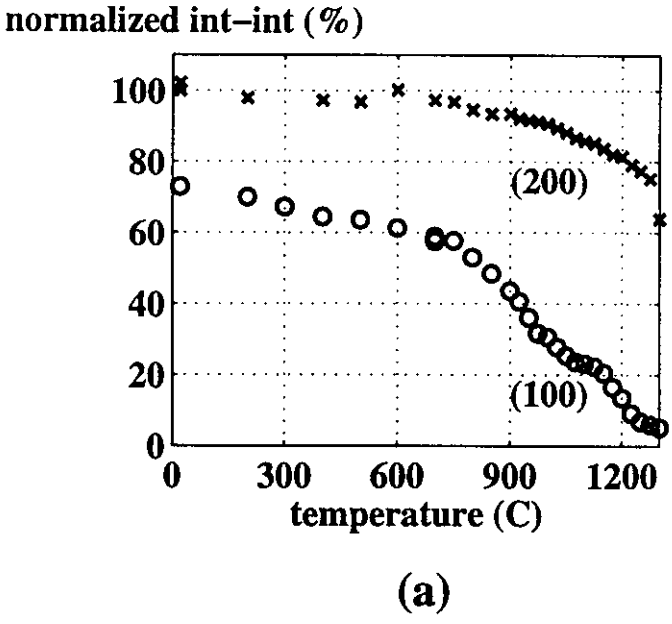
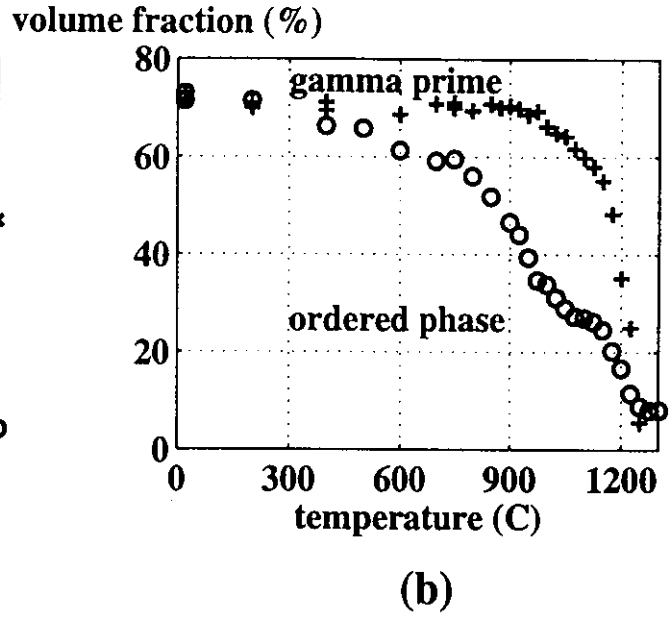
Report: Single crystal nickel base superalloys are used for the high-temperature parts of aircraft engines like turbine blades. Their good mechanical properties at high temperature are related to the precipitation of an ordered γ ' phase which induces a structural hardening of the material. The γ ' phase has an ordered $L1_2$ structure while the γ matrix is disordered and has a FCC structure. The volume fraction fγ ' of the γ ' phase evolves with the temperature and a complete solutionizing occurs above 1280°C in the AM1 superalloy. The γ ' phase of Ni based superalloys is usually analysed through its prototype Ni_3Al. As the Ni_3Al structure remains totally ordered up to temperature very close to the melting point, it is commonly assumed in superalloys that the γ ' phase precipitates are fully ordered up to their solutionizing and that the volume fraction of the precipitates is equivalent to the volume fraction of the ordered phase. However, in superalloys, it is difficult to separate experimentally the effects related to the solutionizing of the precipitates from those due to a possible partial disordering of the γ ' phase and this assumption has not been verified yet.

Using the TCD, installed on the high energy beamline at the ESRF, the effects related to the partial disordering of the γ' phase and those related to its solutionizing were separated experimentally on nickel based superalloys. A study as a function of temperature was performed up to 1300°C. It evidences a partial structural disordering in the γ' phase of AM1 superalloy above 800°C. This disordering was not observed in the pure γ' specimen, therefore it is strongly related to the diphasic structure of superalloys. Several hypotheses are suggested to explain the occurrence of this disordering and its evolution with temperature, but other experiments are required to clarify the involved mechanisms. However, this disordering must have some influence on the elementary strain mechanisms at high temperature and cannot be neglected to explain mechanical properties of superalloys.



(a)



(b)

Temperature evolution of (a) the integrated intensity of the (100) -o- and (200) -x- reflections, (b) the ordered phase volume fraction -o- and the γ' phase volume fraction -+-.

This work is accepted for publication in **Scripta Mater.**