ESRF	**Experiment title: "In situ" deformation at high temperature of Ni base single crystal superalloy: relation between the evolution of the lattice parameter mismatch and internal stresses at the phase interfaces**	**Experiment number**: ME 19
Beamline: ID15A	**Date of experiment**: from: 02-23-2000 to: 02-29-2000	**Date of report**: September 2000
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Report:

Nickel base superalloys are used for the manufacture of aircraft turbine blades. In these alloys, the mechanical properties at high temperature are due to the precipitation of an ordered γ' phase ($L1_2$ structure) inside a disordered γ matrix (FCC structure). Most of their mechanical properties are related to the lattice parameter mismatch δ between the two phases and to the coherency of the lattice at the interfaces. During a plastic deformation at high temperature, dislocations appear to reduce the internal stresses and induce the precipitate morphology evolution from cuboïds to platelets (rafts), more or less distorted depending on the deformation level.

It was shown that the lattice mismatch is influenced by the precipitate shape and by the deformation level (1). So a mechanical testing machine was developped at Nancy to perform high energy diffraction experiments at temperature up to 1500 K under compressive or tensile stress up to 5000 N. A first experiment was performed on the triple crystal diffractometer of the ID15A beamline (experiment number HS 651). It allowed us "in situ" measurements of the lattice mismatch in parallel to the rafts, during a creep test (150 Mpa, 1323 K during 43 hours and then 1353 K up to rupture) on a AM1 superalloy sample.

A strong correlation of the lattice parameter mismatch with the deformation curve was evidenced (2) and a microscopic mechanism was proposed to explain the observed behaviour (3). From this model, a time evolution of the misfit perpendicularly to the rafs was predicted. During the experiment ME 19, this measurement was performed. Results are reported on the figure where the different curves correspond to the time evolution of the misfit at different temperatures. Although the analysis of the data is not fully achieved, it can be noted that the observed behaviours are in agreement with the prediction of the model and rely on its validity. Similar experiments on a superalloy of the new generation (MC-NG) will allow to check the sensitivity of the model.

(1) A. Royer, P. Bastie, M. Véron
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(2) A. Royer, P. Bastie, M. Véron, A.Jacques
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(3) A. Royer, A. Jacques, P. Bastie, M. Véron
Mat. Sci. Eng. (in press)