| ESRF | **Experiment title:** Very high temperature plasticity of a rafted single crystal superalloy: microstructure dependence | **Experiment number**: MA 1747 |
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| **Beamline**: | **Date of experiment**: from: July 3rd 2013 to: July 9th 2013 | **Date of report**: 01/09/2014 |
| **Shifts:** 18 | **Local contact(s)**: Thomas BUSLAPS | *Received at ESRF:* |


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## Report:

The aim of the proposal was to detect an influence of the specimen microstructure (width and length of the rafts) on the mechanical behaviour of rafted single crystal superalloy specimens. A secondary aim was to compare experimental diffraction peaks with diffraction peaks simulated using a method developped at IJL.

Eight specimens were prepared from as cast superalloy rods after different heat treatments (temperature, time) chosen to generate cuboids microstructures with different cuboid sizes (between 0.25 µm and 0.6 µm). Half of those specimens were pre-strained at high temperature in the lab in order to obtain rafted microstructures with different periods.

During the tests the specimens were strained in situ in a high temperature in vacuum tensile device while successive Three Crystal Diffactometer analyzer scans (200 points with 1 second of arc steps and a 1 s counting time for each step) were used to probe the distribution of lattice parameters within the specimens.

The TCD setup used a pre-monochromator and two Si single crystals as monochromator and analyzer respectively in Laue conditions with (311) reflections.

Several technical difficulties were met during the tests (pre-monochromator – monochromator setup, specimen orientation and failure of the step motor controlling the load on the tensile device.) However, two

specimens could be tested by creep under variable stress as programmed. After the failure of the motor, high temperature annealing tests were performed under zero load.

## Results:

a; Tensile tests.

The mechanical behaviour of the specimens prepared with a large period microstructure was markedly different of the behaviour of those with a so called “standard” microstructure: the strain rate was much higher.  Further microstructural investigations by TEM are under way to measure the precipitate sizes and dislocation densities.

b; High temperature annealing

The figure shows the evolution of the diffraction peak due to the spontaneous loss of coherence of the precipitates during a very high temperature annealing: the height of the γ’ peak decreases while the γ peak increases. A simulation of the diffraction peak with a simplified model of the microstructure with interface dislocations having a.<100> Burgers vectors instead of a/2.<110> leads to a correct separation between the peaks but underestimates the peak width. The peak simulation involves the computing of the displacement field within the material. Further improvements (realistic Burgers vectors, effect of partial beam coherence) are under way.

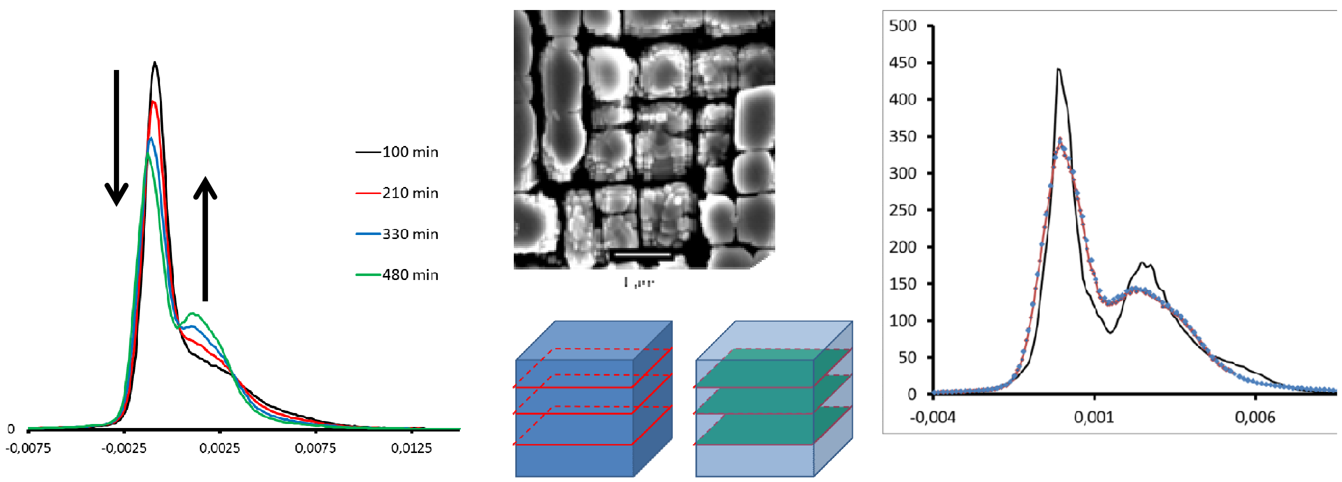


*Figure: evolution of the TCD diffraction of a superalloy with a cuboid microstructure during a very high temperature annealing and spontanous loss of coherence. B) Experimental; b) microstructure and model; c) comparison of the calculated (black line) and experimental peaks (the difference is related to the choice of the interface dislocations.)*