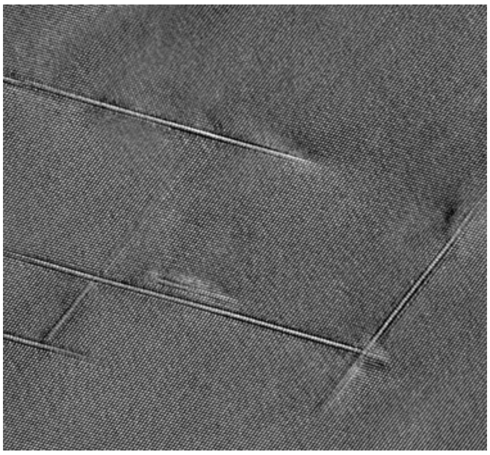
ESRF	**Experiment title:** Quantitative assessment of platelet precipitate morphology in the Al-Cu-Li system by SAXS : in-situ measurements during thermal and themo-mechanical treatment	**Experiment number**: ME254
Beamline: BM02	**Date of experiment**: from: 03-07-08 to: 04-07-08 and from 27-11-08 to : 2-12-08	**Date of report**: 30-03-09
Shifts: 12	**Local contact(s)**: F. Bley, I. Morfin	*Received at ESRF:*
Names and affiliations of applicants (* indicates experimentalists): A. Deschamps*, F. Bley*, B. Decreus*, F. de Geuser* SIMAP, DU, BP 75, 38402 St-Martin-d'Hères Cedex		

Report:

ESRF Small-Angle X-ray Scattering was used in order to characterize the influence of external applied stress on the precipitation kinetics of the T1-Al2CuLi phase in aluminium alloys.
This phase is responsible for the main part of the exceptional hardening in the newly developed 2000 3rd generation Li-containing alloys. It has a very anisotropic morphology: thickness of 1 nm, length up to 100 nm. With such morphology, we expected to detect a very strong effect of applied mechanical stress on the lengthening kinetics of the precipitates, which would be due to partial relaxation in some directions of the elastic misfit stress.

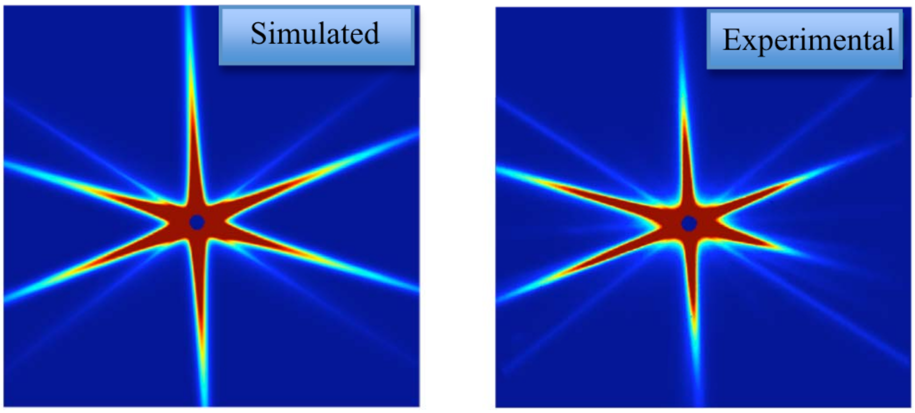


HREM image of T1 precipitates

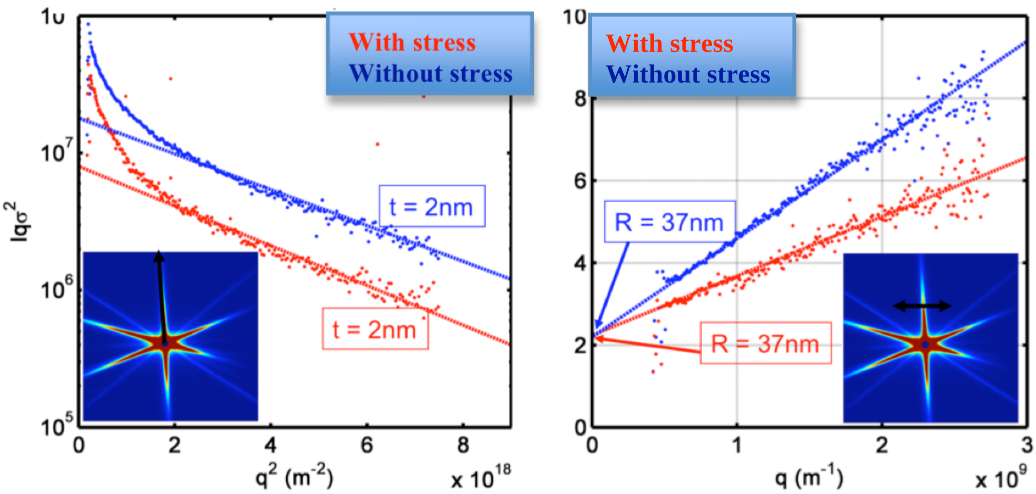
The experiments were devised as such:
- some specimens were aged prior to the experiment under various conditions of stress and time at 155°C;
- some specimens were aged in-situ during the experiment under the combination of stress and temperature in the range 120°C – 155°C. The stress was kept below the yield strength, which had been measured before the experiment by dedicated measurements.

The first outcome of these experiments was that a specific method for determining the morphological parameters of the precipitates had to be applied. Indeed, the material was strongly textured and therefore the precipitate’s signal appears as strong streaks, corresponding to the reciprocal image of the fine platelets. The analysis of these precipitates was complicated by the fact that the thickness of the particles (1 nm) was sufficiently small so that the curvature of the Ewald sphere could not be neglected, and by the fact that some misorientation from the ideal texture components of the material’s grains caused also some deviation from the Ewald sphere construction. All these corrections have now been included in a procedure to model the data, and figure 1 shows a modelled signal compared to the experimental one.
Using this method, a quantitative analysis could be obtained of the precipitate morphology in various situations, notably with various levels of applied stress. It was actually found that the effect of stress had no

influence at all on the growth rate of the precipitates (figure 2). Actually, the microstructure is found to be remarkably independent on applied stress, which had never been characterized before.



(a) simulated signal from the SAXS experiments (b) experimental signal. The strong streaks are due to teh Al2CuLi phase, the weak ones to the Al2Cu phase.



(a) Profile along a streak (corrections applied) ; the slope gives the measurement of the precipitate thickness ; (b) profile across a streak (corrections applied) ; the intercept with the y-axis gives the precipitate length.

Finally, we have also investigated the transition (stress free) between a low-temperature microstructure (including Al2Cu precipitates, at 120°C) and a high temperature one (155°C, including T1 phase). The texture anisotropy of the material enables to separate the two precipitate families, and thus to determine independently the kinetics of evolution of the two precipitate families. Again, such measurements had never been achieved previously.

Two publications are in preparation on this work.

<u>Conclusion :</u> this work has given rather unexpected, but very good, results. It has been the opportunity to improve the data interpretation procedures, applied to textured materials with highly anisotropic precipitates.