ESRF	**Experiment title:** **Study of the residual stress state in 6061 Al-SiC composite after a T6 treatment and its relaxation after severe annealing**	**Experiment number**: ME-858
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Report:

The Residual Stress State has been determined in a Metal Matrix Composite by means of X ray diffraction. On one hand, we attempted at studying the evolution of Residual Stresses from T6 to a fully annealed condition (different times of treatment at 300°C). This was done measuring in the centre of each cylindrical sample, using a relatively large gauge volume (incident slit 1.5×0.15 mm^2, detector slit 0.15 mm wide) and measuring only one central point. On the other hand, the values of residual stress have been determined in three directions along the radius of the cylindrical samples for some of the precipitation states, namely, T4 (or "as quenched"), T6 (or fully hardened condition) and over-aged condition. To this end a smaller gauge volume (incident slit 0.6×0.1 mm^2, detector slit 0.1 mm wide) was used, to increase the spatial resolution. It has been previously calculated that at a diffraction angle of about 10°, 0.1 mm primary and secondary slits lead to a 'core' gauge volume (defined as 75% of the diffracting volume) of about 500 μm. In all cases the $\sin^2\psi$ technique was used. For the first experiment the symmetry condition $\varepsilon_{hoop} = \varepsilon_{rad}$ was exploited. This allowed running only one ψ (sample tilting angle) scan each point in the sample. For the second experiment two sets of scans were necessary: one spanning from the radial to the axial direction, the other from the hoop to the axial direction. The experiments were performed using monochromatic 60 keV beam energy (λ = 0.206 Å).

The materials studied were 6061Al reinforced with 15% Silicon Carbide (whiskers) and the correspondent unreinforced alloy Al 6061. 6061Al and SiC powders were used as a reference. They have been canned into small Al cylindrical containers The 6061 Al powders were treated correspondingly to the bulk matrix and composite materials. Both the composite and the unreinforced alloy were prepared by a powder metallurgical route, and extruded to a bar of 8 mm of diameter, what leads to a matrix texture (<111>+<100>, typical of fcc metals) and some orientation of the reinforcement along the extrusion axis. The bars were machined to obtain cylindrical samples of 6.5 mm of diameter by 13 mm of length.

The samples were mounted on a sample holder made of Poly(methyl methacrylate), fabricated at FaME38. On this sample-holder one can mount several samples and align them to scan all the samples in one single macro. The experimental set-up is shown in Fig.1. The strain is obtained by extrapolation of the d vs sin2ψ values to the axial, hoop and radial directions. The stress can be calculated upon application of Hooke's law.

T4 and T6 treated samples (both matrix and composite) were thoroughly scanned. The preliminary analysis of these measurements (see Fig.2) reveals the behaviour of the principal stress components in the T4 conditions as a function of the specimen radius. There is a clearly symmetric stress profile as a function of radius. The spatial resolution attained is very good. This result could not be achieved by means of previous Neutron Diffraction measurements, demonstrating the necessity of the use of synchrotron radiation. Because

of technical problems to the central computing system of the ESRF the scan on the over aged sample OA crashed.

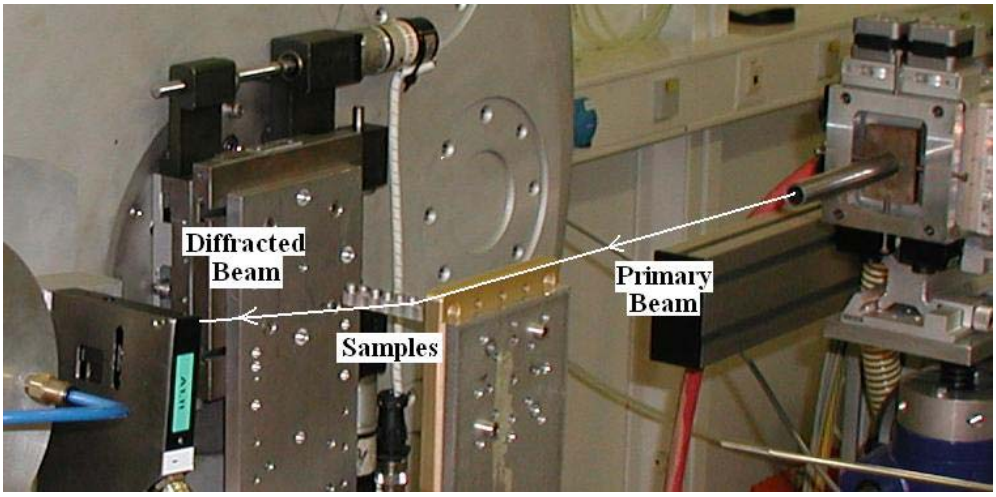

Fig. 1: Experimental set-up

Measuring all the samples (treated at different times of annealing) it is possible to study the relaxation of RS with the annealing treatment. However, a strong texture gradient (fig.3) was found between the centre and the side of the T6 matrix sample. This calls for a thorough investigation of ALL samples: spatial scans along the radius are needed to assess the full RS tensor as a function of the heat treatment.

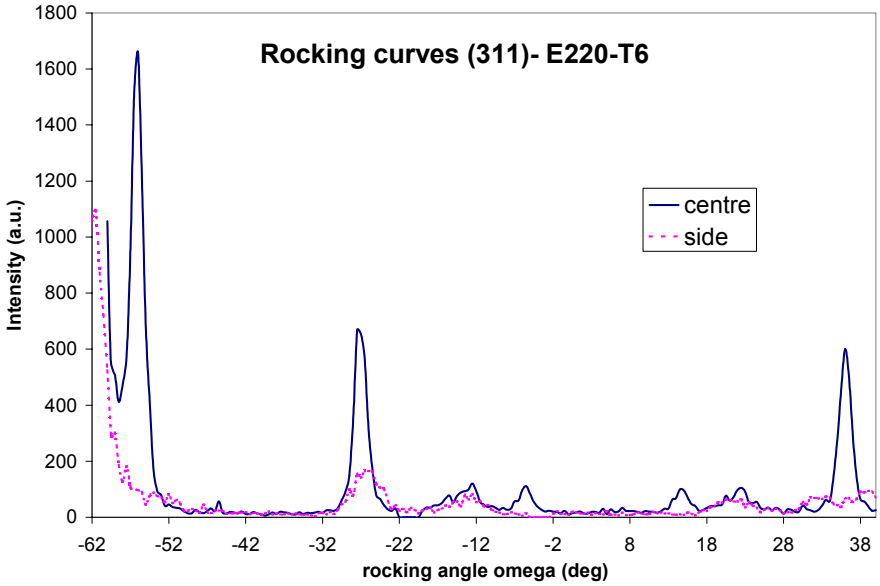

Fig.3 Rocking curve of the T6 6061Al matrix sample, as recorded at its centre and near its edge. Omega = 0 corresponds to the radial direction.

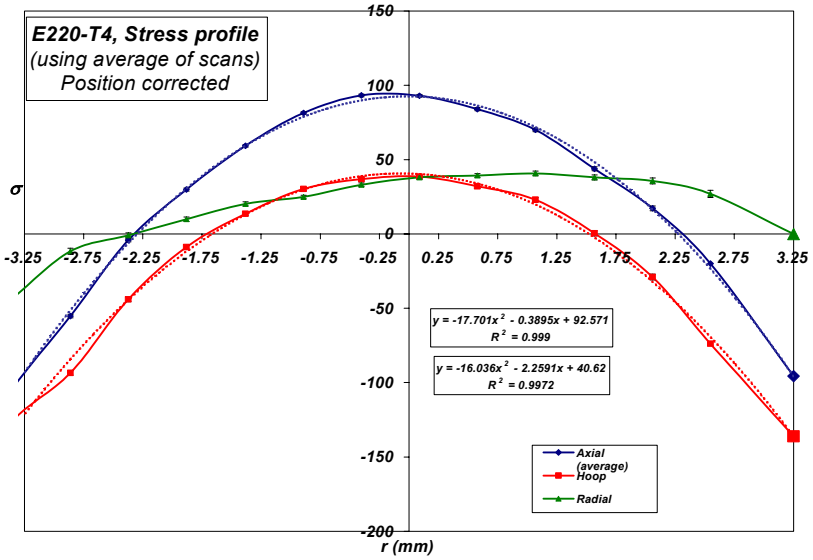

Fig. 2: The RS profile in the T4 sample. A parabolic fit to the data is also shown.
The maximum strain corresponds to the geometrical centre of the sample.