ESRF

Experiment title:
Characterization of the local deformations around individual inclusions in Cu/W composites.

Experiment number:
HC 434

Beamline:	**Date of Experiment:**		**Date of Report:**
ID11	from: 8/4-96	to: 14/4-96	20/8-1996

Shifts:	**Local contact(s):**	*Received at ESRF:*
18	Heinz Graafsma	02 SEP 1996

Names and affiliations of applicants (*indicates experimentalists):

Torben Lorentzen *
Perry Clarke *
Henning Friis Poulsen *
Stephan Garbe *

All: Materials Department
Risø National Laboratory
P.O.Box 49
DK-4000 Roskilde
Denmark

Report:

Composite cylindrical samples are produced by casting copper around along, single-fibre inclusion of tungsten. Samples are subsequently wire drawn to reduce the grain size. Using high energy X-ray diffraction (80.7 keV), the spatial distribution of residual lattice strains are mapped in three dimensions. The axial and radial strain components were successfully measured on a scale of tens of microns and with a precision of $\Delta\varepsilon=1\times10^{-4}$. Large gradients between the sample surface and the fibre/matrix interface -of order 22 to 35×10^{-4} -are found in the axial strains ensamples with different thermal histories. These strain variations are independent of axial position even when measurements were made far from the end of the fibres. On the other hand, the radial lattice strain varies only weakly (of the order of $\pm3\times10^{-4}$). As an example, the axial strain results for one of the samples are shown in Fig 1.

These observations are not consistent with the residual strain variations being due to thermal expansion, or plastic/elastic mismatch between the W-fibre and Cu matrix. In stead we attribute them to deformations of the Cu matrix by the W-fibre as the fibre slip relative to the matrix during wire drawing. This results in a uniaxial compressive stress in the core of the Cu matrix balanced by tensile stresses towards the sample surface similar to the process of inducing biaxial stresses by grinding or shot-peening.

The texture of the Cu matrix was found to vary with radial position, with all samples showing a strong axial (111) texture near the fibre interface and a (111) intensity minimum at the mid-radius, The texture in turn strongly influenced the residual strain field. Finally, heat treating at 300°C for 4 hours reduced the lattice strain variation by a factor of 3.

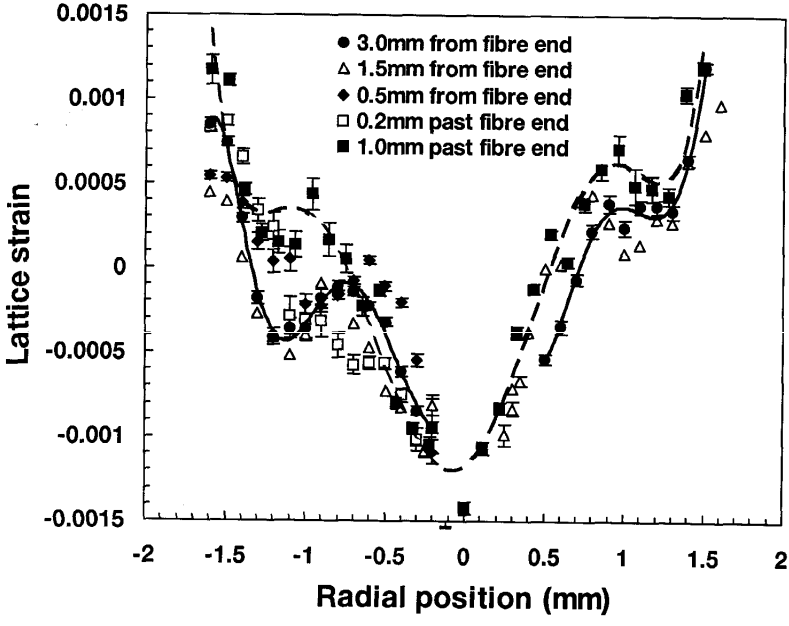

Figure **1.** (111) axial lattice strain as a function of radial position at several axial positions in a 3.2 mm Cu diameter with a 4.5 mm long, 0.5 mm diameter W-fibre along the axis. The solid line is a polynomial fit to the closed circles and the dashed line a fit to the closed squares. They are included as guides to the eye.

This work has been submitted to Composites A. It was sponsored by the Danish National Technical Research Council through the Engineering Science Centre for "Structural Characterization and Modelling of Materials" at Risø and through Dan Sync.