Characterization of the Micromechanical Evolution of Ti-7Al Under Cyclic Loading Using High Energy X-Ray Diffraction Microscopy

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An experiment was conducted at CHESS in which a polycrystalline sample of Ti-7Al was cyclically deformed and mapped using boxbeamnf-HEDM and ff-HEDM [1]. The ff-HEDM shows a decrease in residual elastic strain over the first cycle followed by an increasing build-up of strain. The initial residual strain in each grain was anti-correlated with the change in that same strain component over the first cycle. However, the mechanism for this drop in residual strain has not yet been identified. The distribution in the von Mises stress, which is a scalar measure of shear stresses, broadens with increasing cycles and develops a long tail at the upper end of the distribution. Initially, a graph of hydrostatic stress against stress coaxiality [2] angle shows a positive correlation but after about 65 cycles, the trend-line has rotated to a negative correlation. By cycle 200, the hydrostatic stress vs. stress coaxiality angle is a scatter plot with no obvious trend, Fig. 1. The macroscopic strain stabilizes to less than 1 % change after the first cycle. However, through continual cyclic loading, the grain level strain first stabilizes to 80 % of the grains having less than 1 % change in von Mises strain, but then continues to evolve after cycle 140.

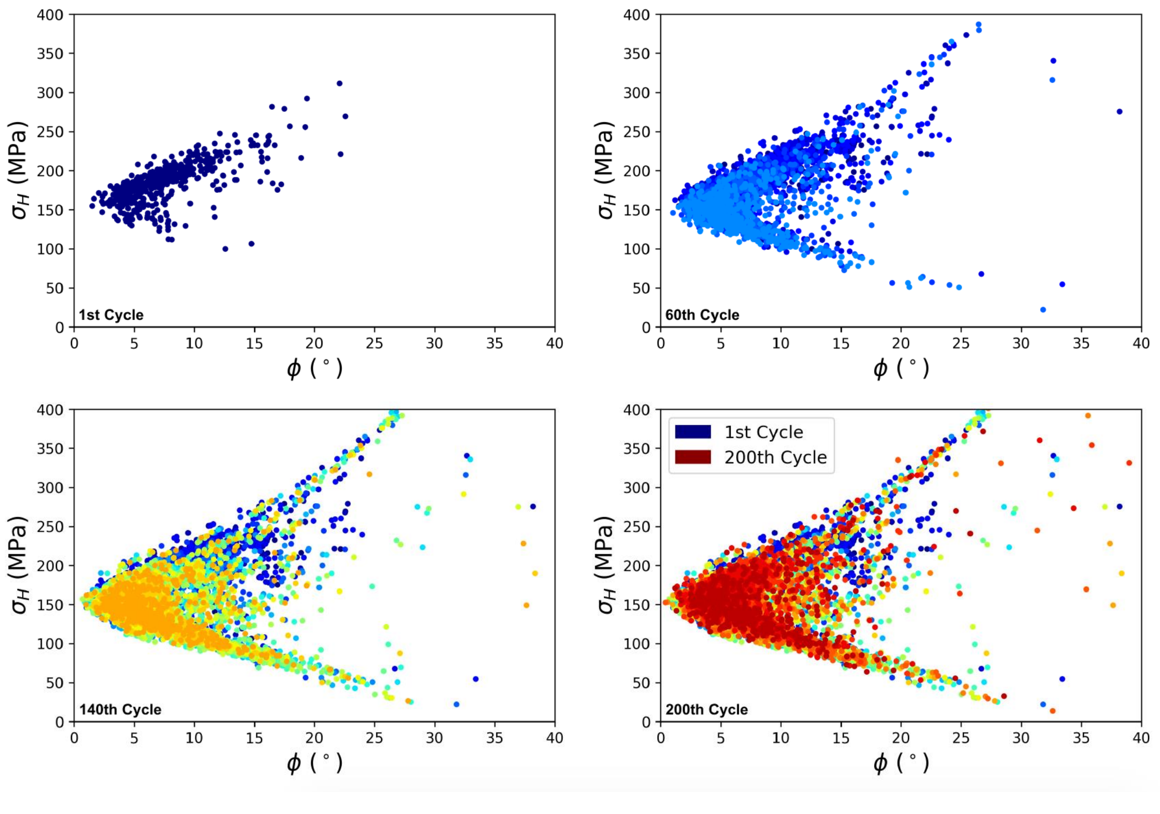

Figure 1 :Plot of the hydrostatic stress, σ_H versus the coaxiality ϕ, for the 1st cycle (top left), the 60th cycle (top right), the 140th cycle (bottom left) and comparing the 1st and 200th cycles (bottom right). At first, the hydrostatic stress and coaxiality angle are positively correlated but the reverse trend becomes apparent after cycling, which is similar to the observations of Schuren et al. [2].

Références

[1] ï J. V. Bernier *et al.*, J. Strain Analysis Eng. Design, **46** 527 (2011).

[2] ï J. C. Schuren*et al.*, Curr. Op. Solid State Matls. Sci., **19** 235 (2015).