TEMPERATURE-DEPENDANCE EVALUTATION ON DEFORMATION PROCESSES IN THE ALLOY 718 USING HIGH-RESOLUTION DIGITAL IMAGE CORRELATION

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Investigating the localization of the plasticity as a function of the microstructure in polycrystalline material is critical to elucidate mechanical properties – microstructure relationships. The temperature-dependence on plastic localization is presently investigated during monotonic loading on a polycrystalline Alloy 718. Tensile tests under controlled atmosphere with *ex-situ* high-resolution digital image correlation (HR-DIC) measurements were performed at room temperature, 350°C, and 650°C. The atmosphere was adapted to limit (i) the contribution of oxidation during mechanical tests and (ii) severe variation of the speckle pattern at the specimen surface for tracking purpose.

Transgranular slip is observed as the primary deformation mechanism at room temperature and 350°C. Of interest, intense slip events develop near and parallel to coherent twin boundaries even below the macroscopic yielding of the material [1-3]. At 650°C, strain localization distribution differs drastically from room temperature and 350°C. Grain boundary sliding is observed to control plastic deformation of Alloy 718 at elevated temperature. Intense strain localization in the vicinity of grain boundaries is observed with and without the presence of transgranular slip events, as shown in Figure 1. Through the correlation between the grain structure and plastic localization, the intensity of strain localization at grain boundaries is observed to depend on grain boundary character, *i.e.* low angle boundaries versus high angle boundaries.

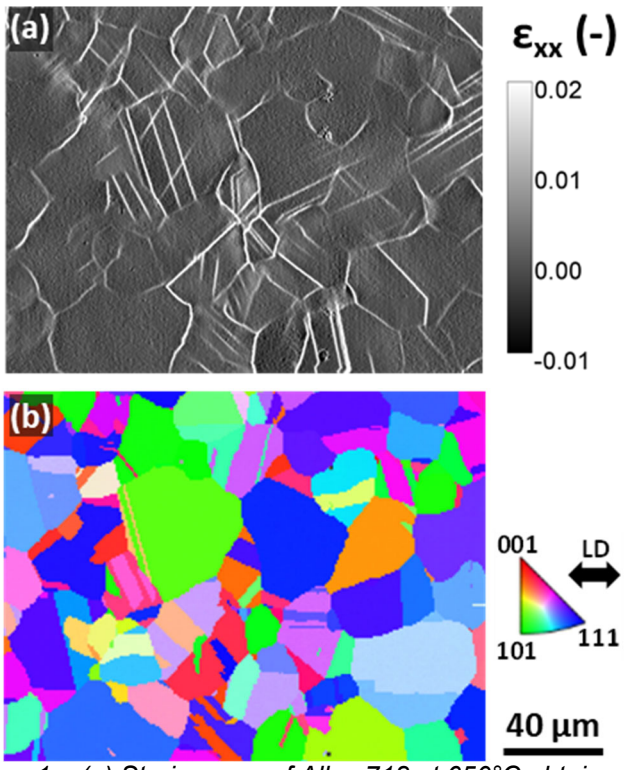

Figure 1 – (a) Strain maps of Alloy 718 at 650°C obtained using HR-DIC techniques. (b) Electron backscatter diffraction map of the region of interest (inverse pole figure along the macroscopic loading direction).

HR-DIC measurements is used during deformation from room temperature up to 650°C to capture the localization of the plasticity quantitatively and statistically as a function of the microstructure and involved deformation mechanisms. The intensity of the grain boundary sliding in Alloy 718 is also found to be sensitive to the applied strain rate and lead to premature intergranular cracking at low strain rate at 650°C. Scanning electron microscopy and transmission electron microscopy observations are performed to relate dislocation structures to deformation mechanisms and slip localization. The temperature-dependence on deformation processes and the strain rate effect in Alloy 718 is elucidated through the investigation of plastic localization. Results are discussed in relation to damage nucleation modes and the presence of dynamic strain aging (DSA)/ Portevin-Le Chatelier (PLC) effects at the different investigated temperatures.

References:
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