PREFERRED EAC INITIATION SITES IN 7XXX ALUMINUM

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The higher susceptibility of new-generation 7xxx series aluminum alloys, such as AA7085, to EAC in humid air, compared to established alloys such as AA7050, has been demonstrated recently [1]. At present, however, the factors leading to their inferior performance require better understanding. We have conducted multi-scale, multi-modal characterization of numerous crack initiation sites from both AA7085 and AA7050 alloys to investigate the mechanisms controlling EAC *initiation* and the early stages of crack growth. Cracks were produced via four-point bend tests within a controlled environment (70°C, 50% R_H), at stresses below yield and were monitored via *in-situ* optical microscopy [2]. Our recent results suggest that ligaments between surface-connected gas pore clusters (often associated with intermetallic particles) are preferred EAC initiation sites in these alloys. We also see evidence of corrosion, involving condensed water, localized at these sites which is crucial in defining the early stages of EAC in these experiments. Adjacent to the initiation sites we see crack arrest markings in the form of bands of elevated oxygen signal, indicating continued localized corrosion during the short-crack period, which is absent in later stages of the cracking.

To further understand EAC initiation in AA7085, low damage *fs*-laser serial sectioning tomography (SST) has been performed on a ~275 x 350 x 550 µm block containing a short, isolated crack. Secondary electron (SE) and backscattered electron (BSE) images and electron backscattered diffraction (EBSD) maps were acquired, and this data has been combined and reconstructed in 3D, allowing us to interrogate the microstructural features which define *preferred* EAC initiation sites in these experiments. Furthermore, tracking of the crack path through the grain structure, and correlating ligaments, crack tips, branching or deflection points is underway to investigate the importance of the microstructure and reactions in the early stages of EAC. A future aim is to compare with initiation sites in an EAC-resistant 7xxx alloy to better understand how morphological/microstructural aspects of early-stage cracking may contribute to the overall performance of new-generation 7xxx series alloys.

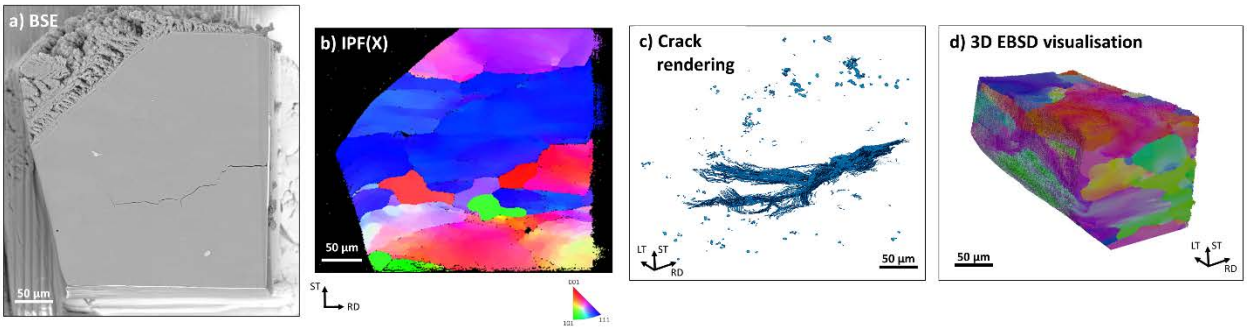

Figure 1 – Overview of the 3D SST data which has been collected: a) example BSE slice from the 3D dataset; b) corresponding EBSD map, showing grain structure surrounding the crack; c) 3D visualization of the crack and porosity, as segmented from the SE images; d) 3D visualization of the grain structure from the EBSD maps.

References

[1] E. Schwarzenböck *et al.*, "Environmental cracking performance of new generation thick plate 7000-T7x series alloys in humid air," *Corros. Sci.*, vol. 171, no. May, p. 108701, 2020, doi: 10.1016/j.corsci.2020.108701.
[2] R. T. Euesden *et al.*, "In-situ observation of environmentally assisted crack initiation and short crack growth behaviour of new-generation 7xxx series alloys in humid air," *Corros. Sci.*, vol. 216, no. September 2022, p. 111051, 2023, doi: 10.1016/j.corsci.2023.111051.