

## **Integrated Use of Synchrotron and Neutron Diffraction to Monitor Residual Stress Evolution in Welded Aerospace Structures**

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The factors controlling fatigue initiation and crack growth in welds are reasonably well understood and the importance of residual stress, HAZ hardness and microstructure is well known. However, previous access to reliable, spatially accurate residual stress field data has been limited. Recent advances in neutron and synchrotron diffraction allow a far more detailed picture of weld residual stress fields to be obtained which permits the development and use of predictive models that can be used for accurate design against fatigue in aircraft structures. This paper describes a fully integrated study of the 3D residual stress distribution accompanying state-of-the-art fusion welds in 2024 and 7150 aluminium aerospace alloys, and how they are affected by subsequent machining and service loading. A particular feature of this work has been the development of integrated neutron and synchrotron techniques allowing the non-destructive evaluation of the residual stress field in the full range of specimens used to provide the design data required for welded aircraft structures. This has included small bend specimens used to study initiation and short fatigue crack growth, centre-cracked panels used to study long fatigue crack growth, and large integral welded double stringer/skin mock-ups used to investigate the likely failure mode of welded wing-skin assemblies.

**Keywords:** residual stress, welded structures, aerospace alloys