Residual Stresses in Titanium Aerospace Components Formed via Additive Manufacture.

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Additive Manufacture (AM) using arc-wire based metal deposition has been suggested as one method to reduce the costs associated with production of titanium components, particularly within the aerospace sector. In the present study two sample components were manufactured from Ti6Al-4V using gas tungsten arc welding (GTAW) with automated 'cold' wire addition to produce layer-wise build-up of a thin walled structure simulating those common in structural aerospace applications. A third sample was created via conventional fabrication techniques with separate plate sections welded together using the GTAW process.

Residual strains, and hence stresses, for each sample were analysed quantitatively using neutron diffraction techniques on the KOWARI strain scanner at the OPAL research reactor operated by the Australian Nuclear Science and Technology Organisation(ANSTO).Results show lower levels of residual stress in samples formed by arc-wire AM compared to the fabricated structure. Additionally, the region of greatest stress is far more localised in the root area of the fillet joint for AM samples. The comparatively lower and more localised strains in AM samples may be attributed to repeated and successive annealing of the build-up as further weld beads are deposited. Some lattice strain measurements in the AM samples showed relatively large uncertainties due to low scattering counts and hence poor resolution of the diffraction peak. This is ascribed to the formation of the formation of localised texturing where α-Ti laths form in aligned colonies within prior β-Ti grain boundaries upon cooling.

Time-of-flight neutron diffraction has been proposed to analyse stresses in both the α-Ti and β-Ti phases simultaneously as well as inter-granular strains. This study forms part of a wider investigation into the suitability of arc-wire based deposition techniques for the additive manufacture of titanium components.

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