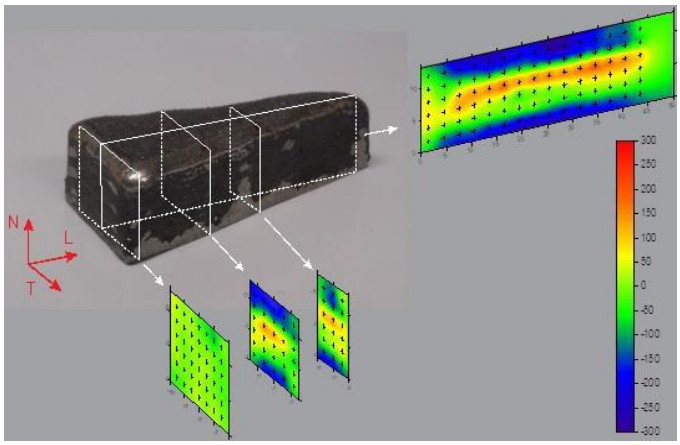
Reducing the cost of manufacturing with steel

Overview

Additive layer manufacturing (ALM) represents a new and novel approach to manufacturing where material is deposited in successive layers to build up a three-dimensional solid free-form structure. This approach to manufacturing has many advantages including reduced material waste and enhanced design flexibility.



Residual stress map in H13 tool steel wedge

Using laser or electron-beam heat sources, powder particles can be melted together on a very fine scale down to a 50µm spot size to produce complex structures such as spline and lattice shapes for biomedical implants, and automotive and aerospace components.

Researchers from CSIRO, ANSTO and Swinburne University have been conducting trials to assess the influence of geometry and section thickness on residual-stress formation during ALM, with different section thicknesses corresponding to both different cooling rates and constraint conditions.

By producing wedge-shaped samples of H13 tool steel (the most widely used tool steel for forging and die-casting dies), researchers have been able to show that residual stresses produced are far more dependent on the cooling rate than on the section thickness. This is exciting because it shows that if the parts are cooled slowly after manufacturing, the tensile residual-stress distribution can be reduced or eliminated, irrespective of the section size of the component.

The Bragg Institute's contribution

Using neutron diffraction techniques on the KOWARI Strain Scanner instrument, researchers have been able to non-destructively quantify the residual stresses within several representative structures produced by laser- and electron-beam ALM processes. Researchers have also examined the influence of various processing parameters, allowing them to optimise residual stresses in the final components produced by ALM.

Collaborators

References:

[1] Bragg Peaks ISSUE 29, JAN 14

[2] Cottam, R., Luzin, V., Thorogood, K., Wong, Y.C. & Brandt, M. The Role of Metallurgical Solid State Phase Transformations on the Formation of Residual Stress in Laser Cladding and Heating. Mater. Sci. Forum 777, 19-24 (2014)

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