Experimental report

17/09/2018

Proposal: **INTER-406** **Council:** 4/2018

Title: Residual stress analysis on additive manufactured Ti64 for the ISO-ASTM Non-destructive testing

Research area:

This proposal is a new proposal

Main proposer: **Ben DUTTON**

Experimental team:

Local contacts: Sandra CABEZA

Samples: Ti64I4V

Instrument	Requested days	Allocated days	From	To
SALSA	3	3	15/06/2018	18/06/2018

Abstract:

Report on the viability test of in-situ Inconel 718 wire printing at SALSA

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The set up of a laser wire printed consisted in a COAXwire laser clading system (P_L<4kW) fixed in a portico with and a xyz table on top to help aligning it in the measuring point defined by collimators in primary 2 (horizontal) x 20 (vertical) mm^2 and in the secondary x2 mm. Also, a 2mm horizontal slit was placed in the path of the secondary beam before the detector in order to gain a vertical spatial resolution of about 15mm. A rotation table was mounted on the hexapod and aligned to the position at the baseplate to measure the radial strain component, and then in a following sample the hoop one (see Fig.1). The hexapod table travelled in the vertical direction synchronously with the deposition speed in order to build up a cylindrical geometry (125mm radius). An induction furnace was adapted to the baseplate in order to preheat it before the start of the deposition. A pyrometer recorded the temperature at the baseplate. Infrared and optical cameras were positioned to aid in the processing control and give the temperature gradient input at the melting pool and its surroundings. All signals were connected to the new acquisition system of SALSA working in event-mode. This guaranties the synchronization (up to 8 channels) of important process parameters with neutron detection.

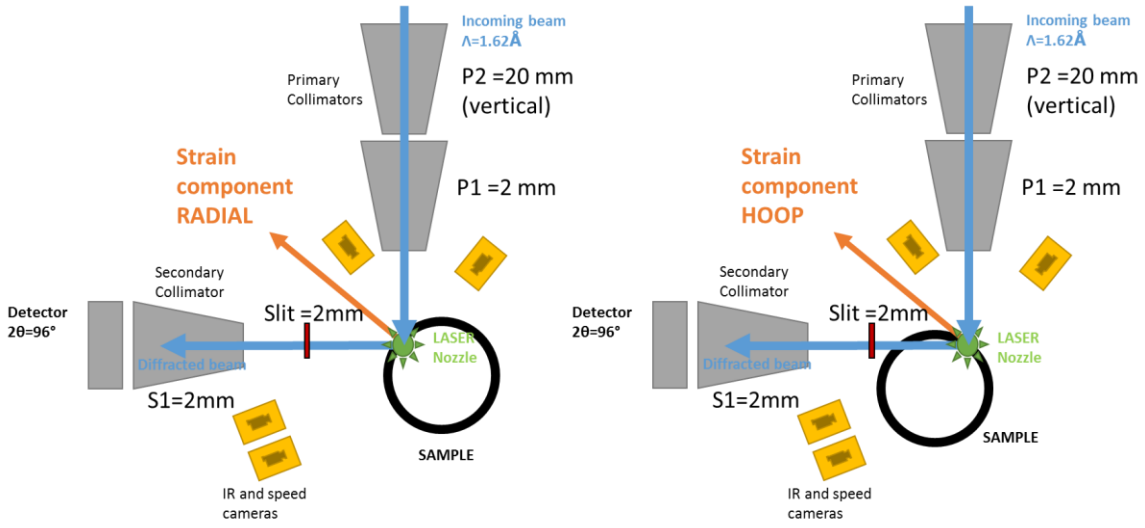

Figure 1. Experimental set up at SALSA for wire additive manufacturing of Inconel-718 (May 2018): set ups for radial and hoop strain components.

Neutron diffraction recording of Ni-311 reflexion started right before the deposition in order to obtain the initial baseplate condition (machined 5mm in height in the center in order to allow its measurement in transmission). The lattice spacing (peak shift) evolution was recorded continuously during the printing and after it finished, until the temperature record indicated room temperature levels. An example of the superposed signal during the complete process is presented in Fig.2. The spatial and time binning of the signal in the detector (vertical spatial resolution in the sample) is under discussion taking into consideration: a) the travelling in vertical direction meaning that different regions are “imaged” at different regions of the detector and 2-the temperature gradients recorded indicating that different binning times may be required at different printed heights during the printing. What could be directly observed is a gradual transition of the peak to higher positions due to the

solidification and cooling process, as well as two phases after a few mm (seconds) build height that are in principle assigned to the baseplate and to the printed material.

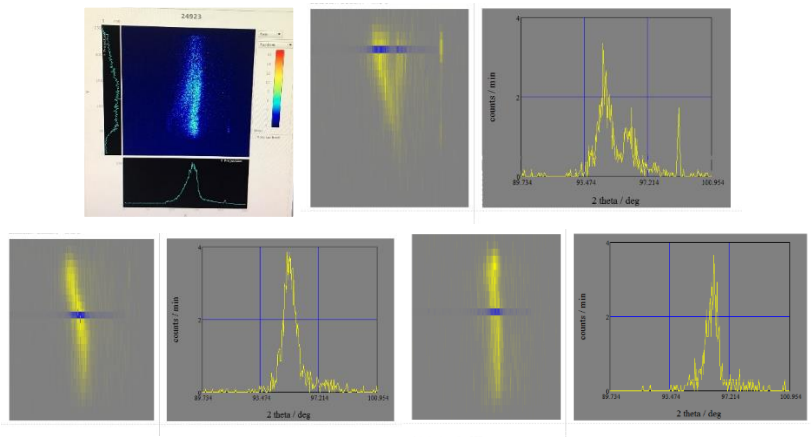

Figure 2. Neutron data acquisition (a) example during the experiment of detector with all superposed signal from the complete fabrication and cooling. In the following: 2D-dector images and peak profiles (b) taken 20s (c) 2min after start and (d) at the end of deposition with a corresponding built height of 1.5mm, 25mm and 80mm respectively (horizontal axis 2θ angle and vertical axis corresponds to position in the wall). The top of the detector images relate to the top of the wall where the deposition takes place. The blue marker shows the position at which the diffraction pattern is extracted.

It could be initially concluded that results demonstrate the viability of the set up for the study case of lattice evolution in the bulk by neutron diffraction techniques for additive manufacturing.