Experimental report

04/09/2015

Proposal: 1-02-156 **Council:** 4/2014

Title: Residual stresses built up in additively manufactured components: processes comparison and post processing influence

Research area: Materials

This proposal is a new proposal

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Sofiane TERZI

Local contacts: Thilo PIRLING

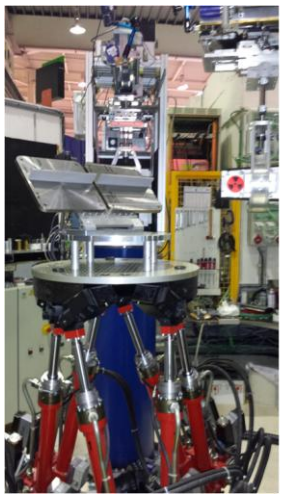
Samples: Ti64

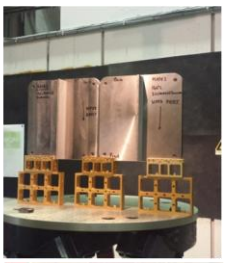
Instrument	Requested days	Allocated days	From	To
SALSA	4	6	30/09/2014	02/10/2014
			11/10/2014	15/10/2014

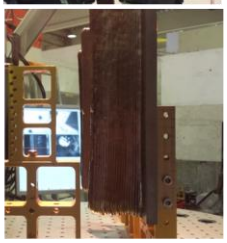
Abstract:

Currently there is a great manufacturing trend in producing higher quality net shape components of challenging geometries. This worldwide tendency has resulted in numerous large-scale research projects on additive manufacturing (AM). The frontrunner European project AMAZE is now the biggest project of its kind in the world. The project’s underlying aim is to rapidly produce large defect-free additively-manufactured metallic alloy components up to two metres in size. One of the major challenges in the project is to understand and control the internal stress distribution in AM parts. Residual stresses generated in a AM part can be significant, and typically lead to unacceptable distortion or degradation of mechanical properties. Therefore, the deep scientific understanding of residual stress/strain distribution is essential for ensuring quality and performance in high-tech AM parts. The aim of this proposal is to compare residual stresses generated in AM components produced by different techniques as well as to investigate process parameters and post processing treatments such as machining, heat treatment and substrate removal.

Report experiment 01-02-156







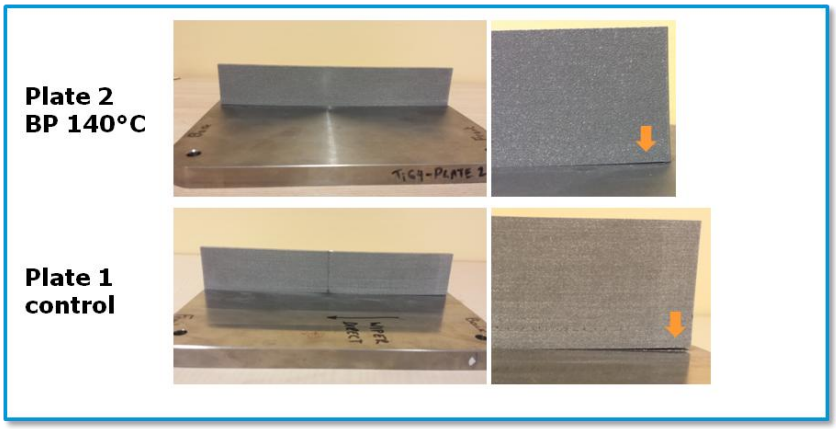
I) SLM builds:

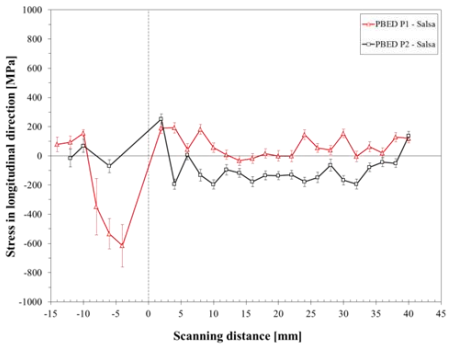
- PBED P1 - Aligned to wiper (reference sample)
- PBED P2 - reference sample built on a 140°C heated plate

II) WAAM builds:

- N1 - Reference sample - As deposited baseline comparison with cooling
- N2 - As-deposited sample + Stress relieve without barrier
- N3 - As-deposited sample + Solution treating and aging cycle

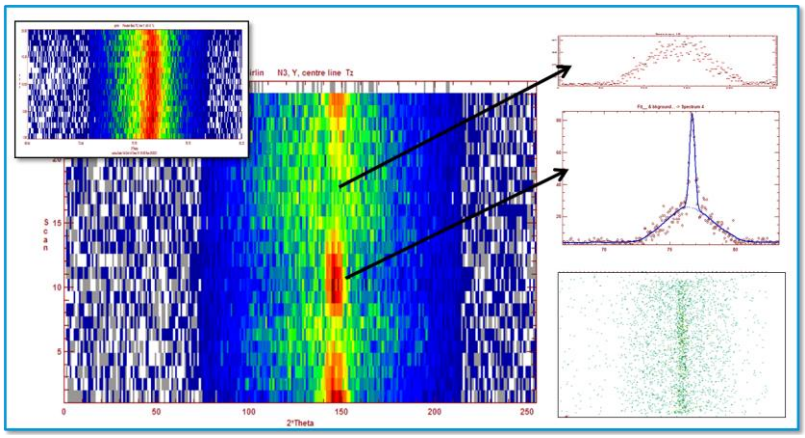
I) SLM builds





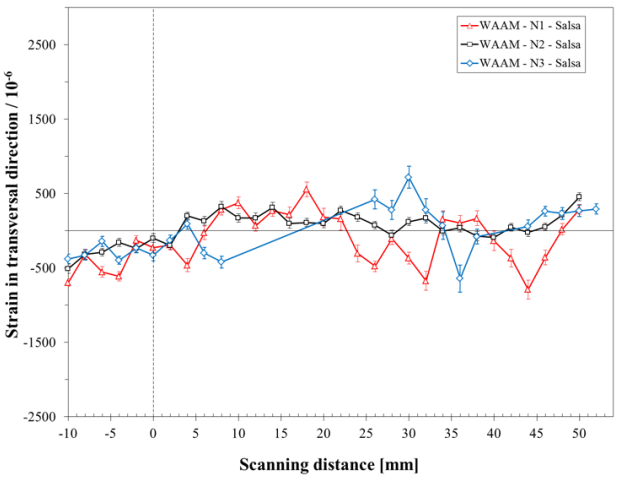
- We found some differences between samples in particular in the baseplate
- Relevance issue due to the presence of cracks

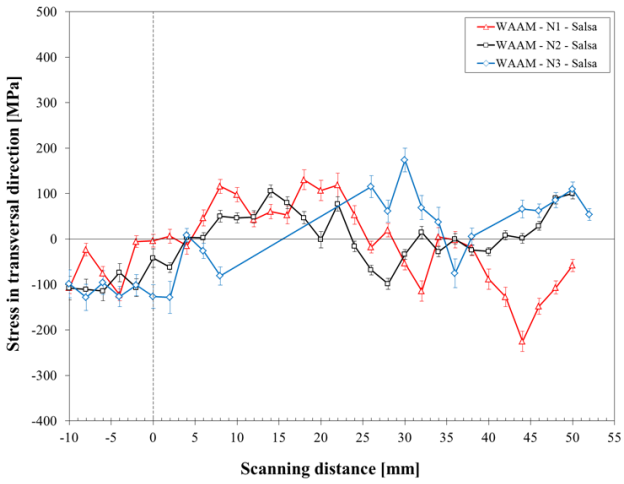
II) WAAM builds

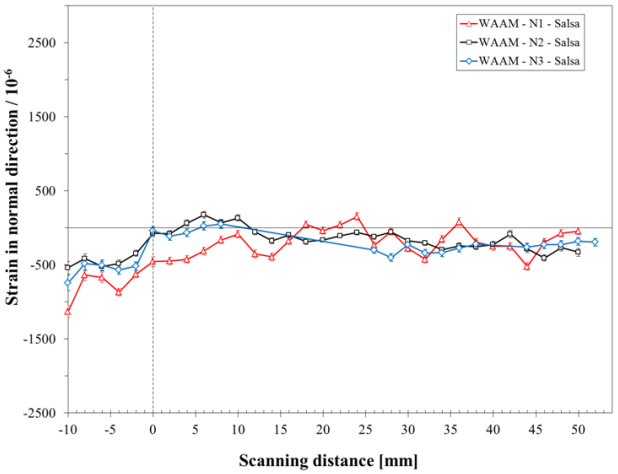


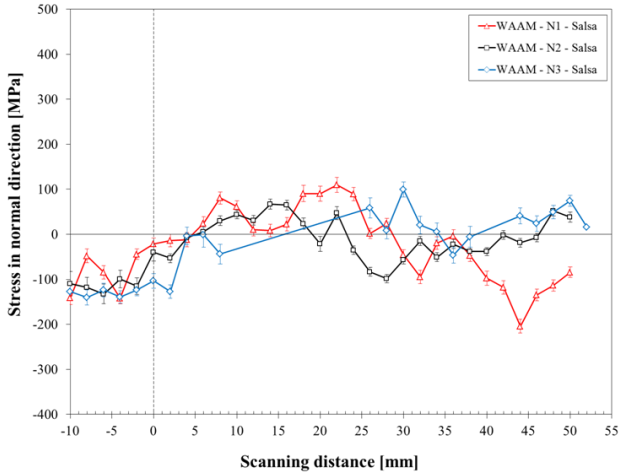
- Texture issue only for the long. direction
- Large β grains → no intensity in some regions
- α Ti (103) plan → diffraction of small α grains
- → Good statistics in diffraction conditions
- Solution: Ω scans at ≠ height (≠ Ω around the long. direct.)
- Determination of a correction method

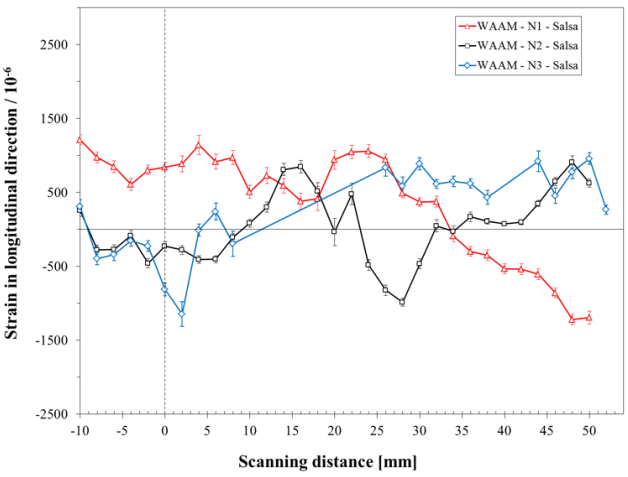
- Strain and stress curves

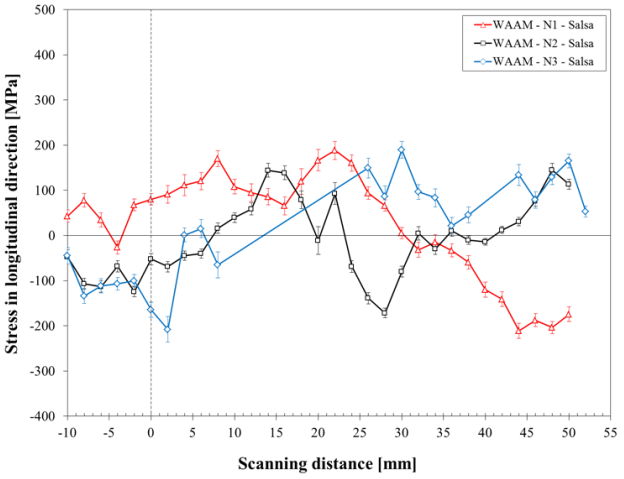




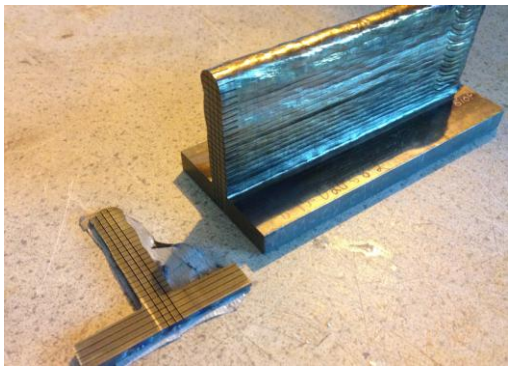








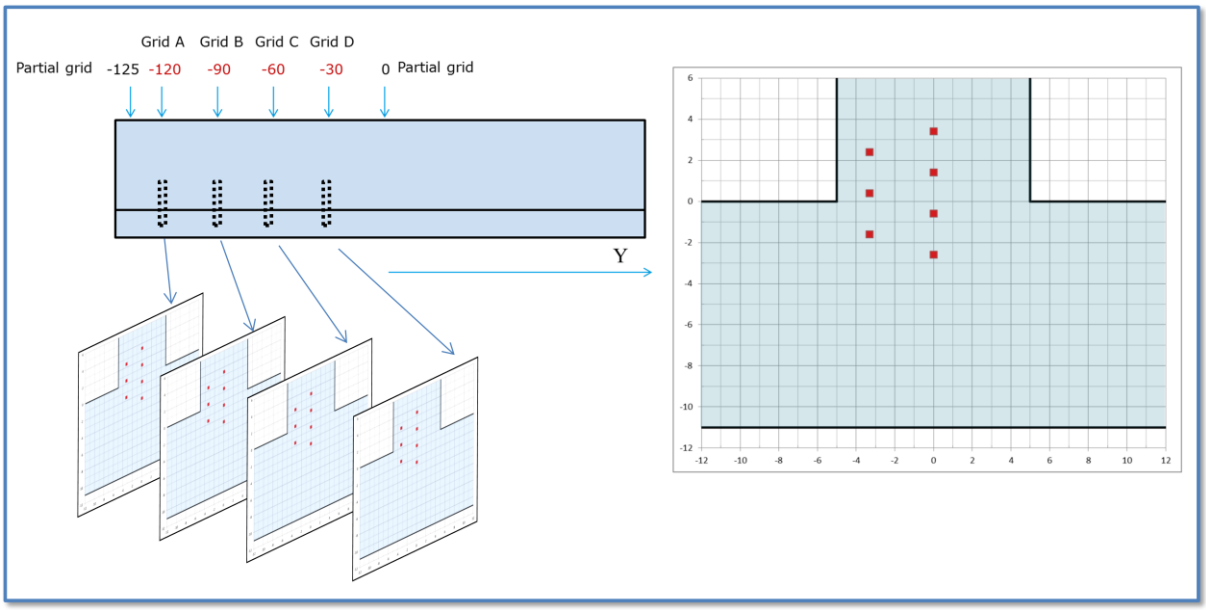
Significant effect of heat treatments -> currently analysed and discussed. A paper is being prepared.



After the experiment, the samples were cut into little d0 coupons (in the middle section) for being measured on Salsa. The further refinement of the d0 value (variation along the vertical direction) is expected to strengthen the results.

- Variation along the longitudinal axis

The evolution of the strain and stress along the longitudinal direction has also been performed. Small grids have been acquired.



Results for the strain in longitudinal direction are shown in the graphs below