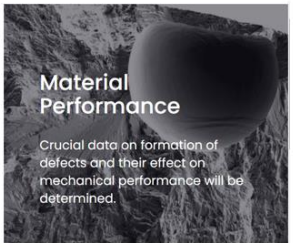
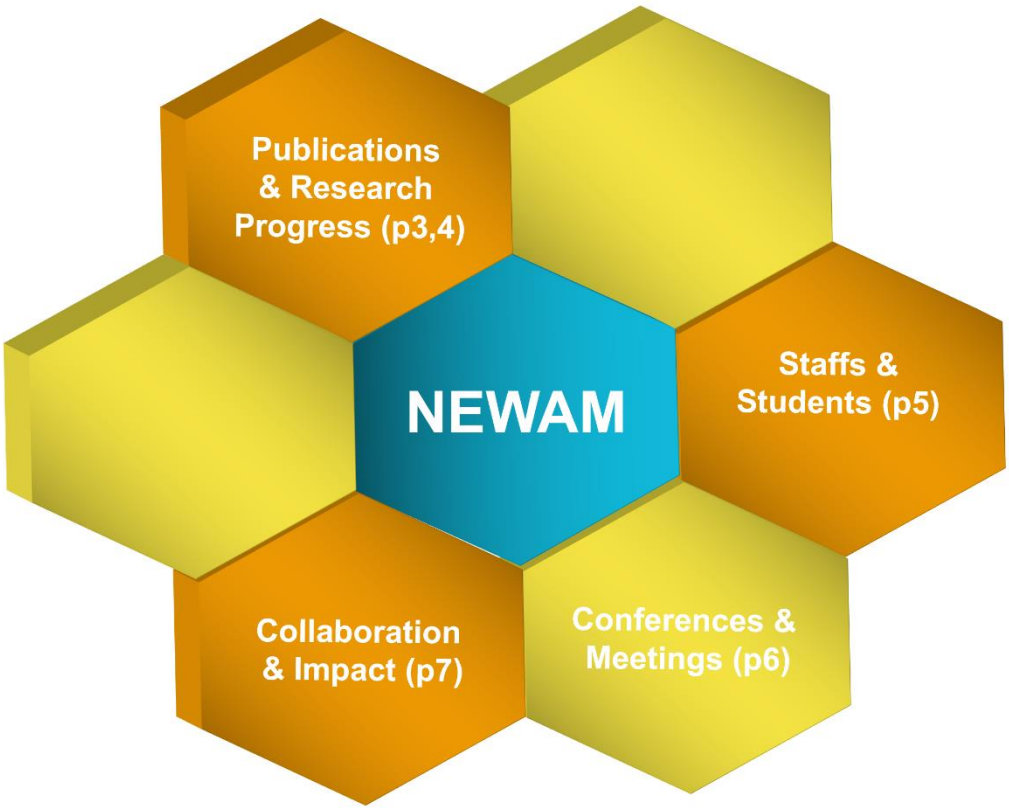
New Wire Additive Manufacturing

Newsletter (3rd quarter, 2021)

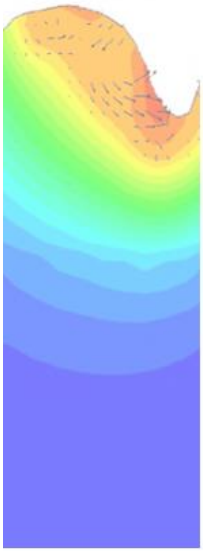


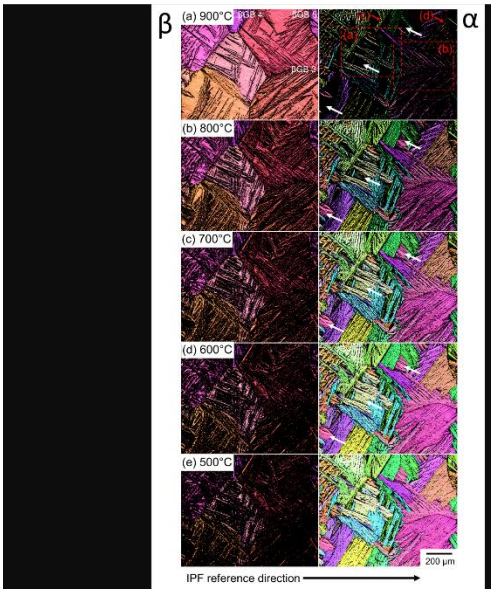
Compiled by NEWAM dissemination committee and released on 4 October 2021

Your NEWAM in July – September 2021



Publications & Research Progress

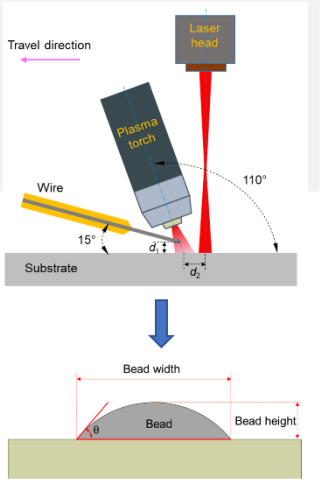


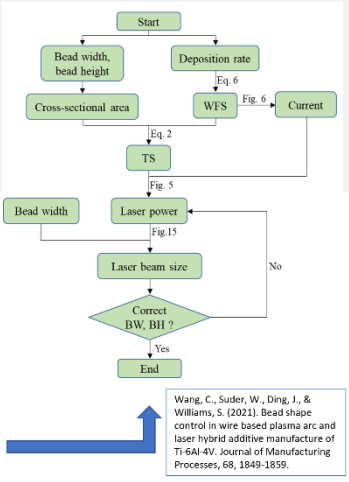


Manchester team's new publication

- Manchester team published a paper entitled 'In-situ observation of single variant α colony formation in Ti-6Al-4V' which shows, for the first time, nucleation of the α phase in Ti-6Al-4V as it is cooled through the β transus, in real time, using an in-situ SEM heating stage. Fundamental metallurgical studies such as these, feed into the on-going research conducted in the NEWAM program and help guide future projects.

Davis, A. E., Donoghue, J., Kennedy, J. R., Byres, N., & Prangnell, P. B. (2021). In-Situ Observation of Single Variant α Colony Formation in Ti-6Al-4V. Acta Materialia, 117315.



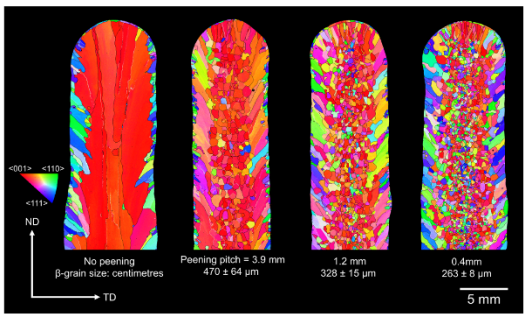


Wang, C., Suder, W., Ding, J., & Williams, S. (2021). Bead shape control in wire based plasma arc and laser hybrid additive manufacture of Ti-6Al-4V. Journal of Manufacturing Processes, 68, 1849-1859.

Cranfield process development team has published a new paper on wire-based plasma arc and laser hybrid additive manufacture of Ti-6Al-4V

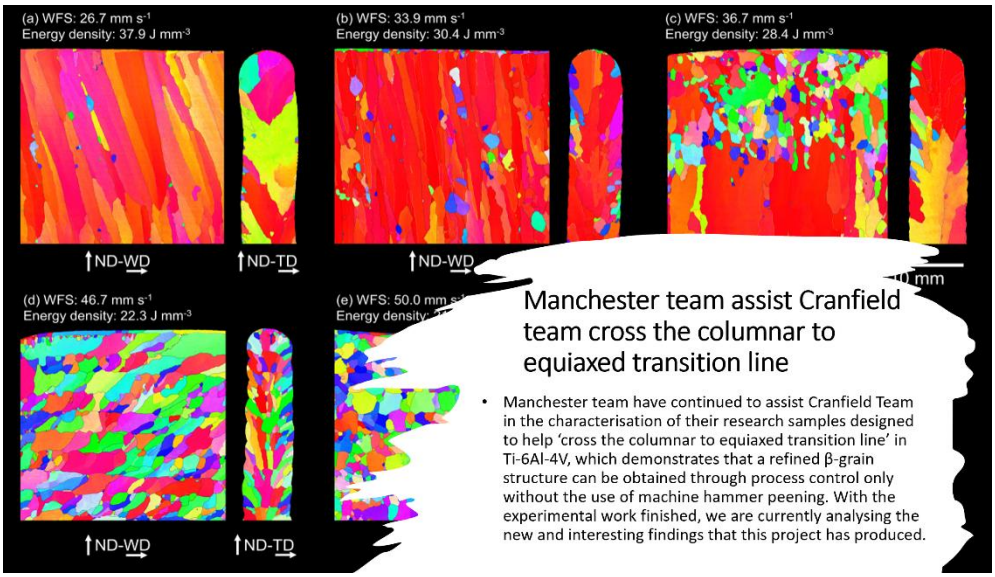
- Wire based plasma arc-laser hybrid additive manufacturing is suitable for building large-scale metal components with high deposition rate and near-net shape, and how to achieve a desired bead profile is essential for the deposition of different geometries. The process development team from Cranfield University investigated the effect of different process parameters, including laser power, energy distribution between the plasma arc and laser, wire feed speed, travel speed, and laser beam size on the deposition process and bead shape, and proposed a control algorithm for controlling the bead shape in the hybrid process.

Manchester team are characterising Ti-6Al-2Sn-4Zr-2Mo alloy WAAM component



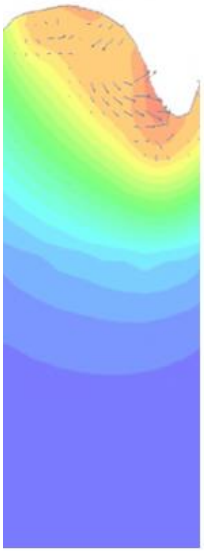
- At the University of Manchester in the last quarter, the team have been primarily characterising the new Ti-6Al-2Sn-4Zr-2Mo alloy WAAM components built at Cranfield University. At time of writing, this important high-temperature-application alloy has only been deposited using WAAM by the NEWAM project. By the use of inter-pass machine hammer peening, we have shown, through EBSD characterisation, that a relatively fine, equiaxed β-grain structure can be obtained, preventing the formation of large, columnar grains which cause the mechanical anisotropy that is common with as-deposited titanium WAAM components.

Publications & Research Progress



Manchester team assist Cranfield team cross the columnar to equiaxed transition line

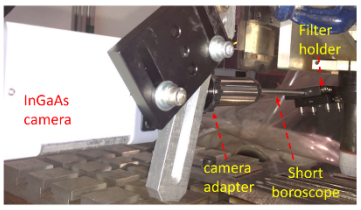
- Manchester team have continued to assist Cranfield Team in the characterisation of their research samples designed to help 'cross the columnar to equiaxed transition line' in Ti-6Al-4V, which demonstrates that a refined β-grain structure can be obtained through process control only without the use of machine hammer peening. With the experimental work finished, we are currently analysing the new and interesting findings that this project has produced.

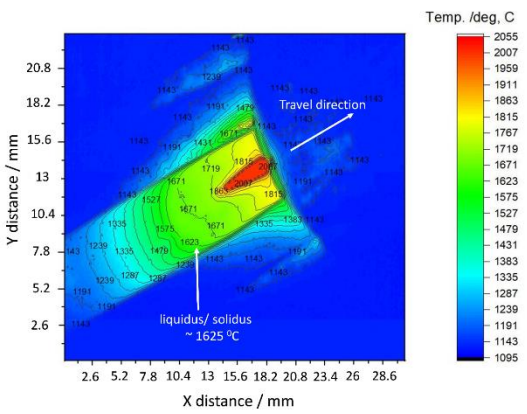


Cranfield Team' research progress on WAAM process monitoring

- During the last quarter a one-channel thermal camera was used to determine the optimal deposition processes for equiaxed Ti64V deposition. A filtered InGaAs camera together with 5mm Φ borescope optics was used to provide images of the melt pool. The filter wavelength and bandwidth were selected to transmit light in the weld thermal emission band but block the argon plasma lines, which would otherwise saturate the camera.

- In the last quarter, a new design for a 2-channel thermal camera system has also been completed. This will use an optical fibre bundle for light coupling and use one camera. The two wavelength images will be simultaneously imaged separately on the camera sensor. This system will allow increased flexibility on measurement head location with respect to melt pool location and potentially will be less sensitive to measurement errors.

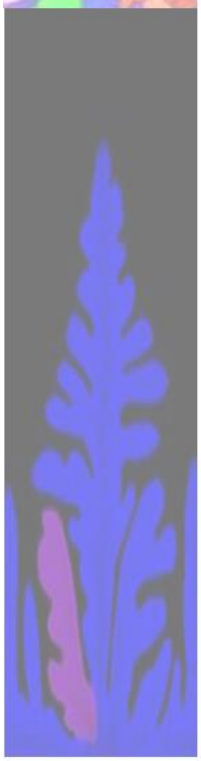


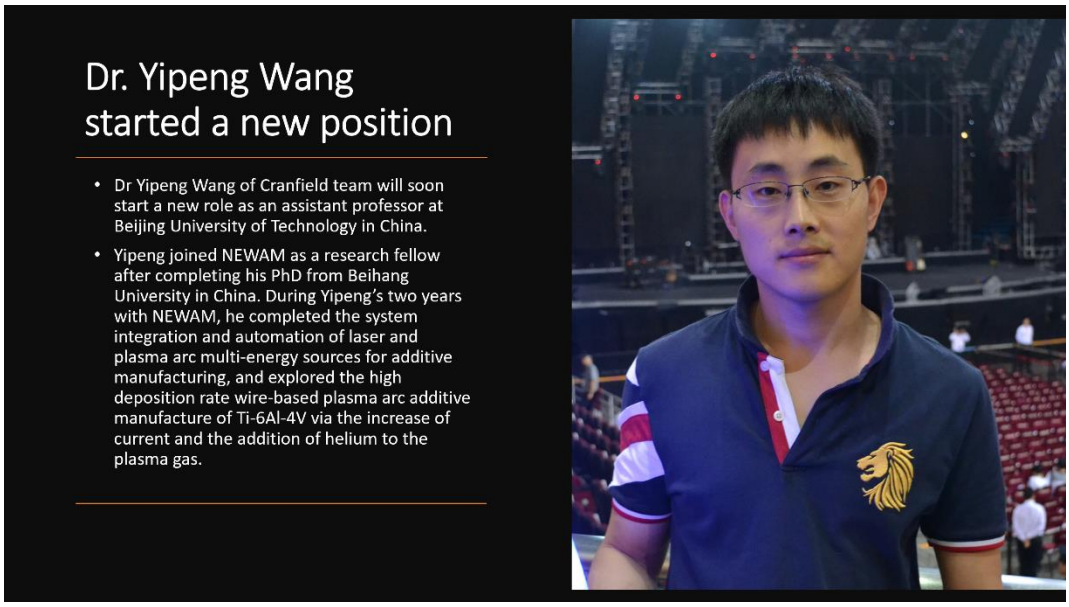


Cranfield Team measured molten pool temperature

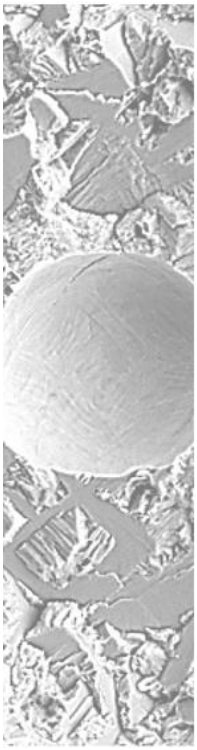
- The figure shows a thermal contour plot of a Ti64V melt pool obtained from the camera. The image was taken in plan-view and the temperature values correspond to published liquidus/solidus transition values for Ti64V. This is the first time these results have been reported in the literature.

Staffs & Students





Conferences & Meetings



Coventry team's presentation in ESIAM-21

Dr. Abdul Khadar Syed led the presentation in The second European Conference on the Structural Integrity of Additively Manufactured Materials, 8-10 September, 2021 (ESIAM-21, https://esiam.eu/):

- This contribution is a joint effort from Coventry University and the industrial partner HBM Prenscia, UK
- There are many challenges for full qualification of Ti-6Al-4V and manufacturing process. One of these key requirements from the aerospace and energy industries, and their regulatory authorities, is the material structural integrity performance under fatigue loading

Recorded presentation: https://www.youtube.com/watch?v=Hrlu4x7Dsb8&ab_channel=EuropeanStructuralIntegritySociety

Coventry University

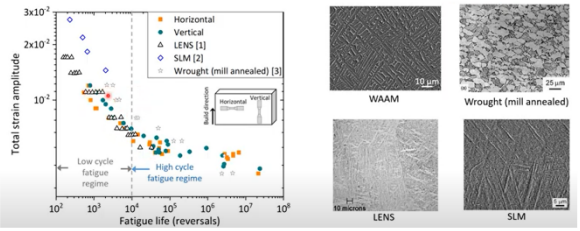
Prenscia

Cyclic deformation and fatigue behaviour of titanium Ti-6Al-4V built by directed energy deposition AM process

A K Syed[1], M Hill[2], R Plaskitt[2], X Zhang[1]

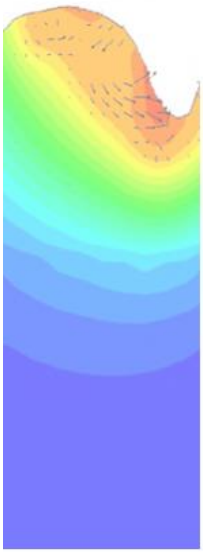
[1] Faculty of Engineering, Environment and Computing, Coventry University, Coventry, UK

[2] HBM Prenscia, UK



- Wider columnar primary β grains consisting α+β in Widmanstätten and colony morphology.
- Cyclic stress-strain curves obtained from fatigue hysteresis loops show typical cyclic softening.
- In the LCF region (<10^4 cycles), vertical build orientation samples, loaded along the columnar β grains, is superior.
- In the HCF region (>10^4 cycles), vertical and horizontal build orientation sample performance is similar, though with considerable scatter in the data.

Collaboration & Impact



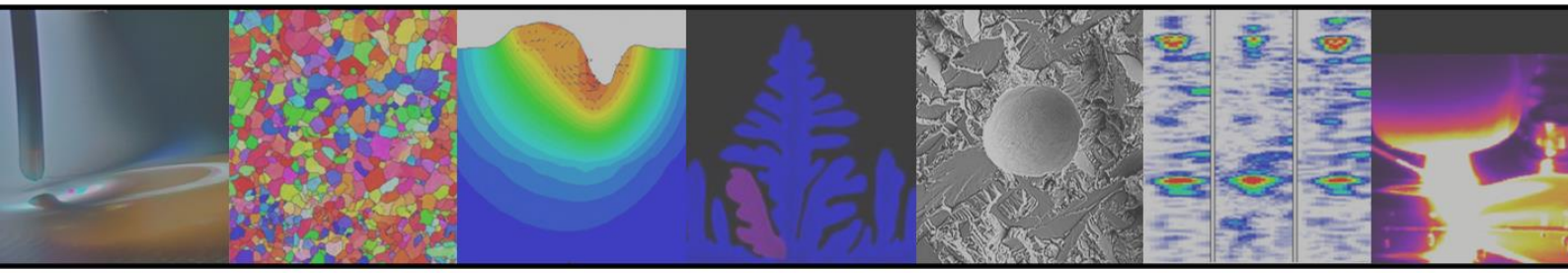
Opening of Robotically-Enabled Sensing (RES) hub at Strathclyde

- The £ 2.5 Million cutting edge Robotically-Enabled Sensing (RES) hub has been opened at the University of Strathclyde. The hub brings together next generation robotics with sensing technology to inspect high value components like aeroplane wings at the point of manufacture and throughout their life to make them quicker, easier and cheaper to build.
- CUE boasts one of the world's biggest automated inspection teams. The group carries out non-destructive testing using ultrasound and other sensors to assess components for structural faults or damage and to ensure they are built correctly.

Opening of Robotically-Enabled Sensing (RES) hub at Strathclyde

- The new cutting edge facility will house 11 robots capable of handling components up to six metres long. The 'heart of the campus' laboratory will also allow collaborative working on applied robotics to drive research, innovation and training and will support research for nine of the University's Chancellor's Fellows.
- It will build on established industrial partnerships, including with Prestwick-based global manufacturer of aerostructures Spirit AeroSystems and collaborations with the National Physical Laboratory (NPL) and KUKA Robotics, one of the world's leading industrial robotics innovators.

New Wire Additive Manufacturing



Further Reading

NEWAM website: https://newam.uk/
NEWAM LinkedIn: https://www.linkedin.com/in/newam-epsrc-programme-grant-6617091a9/
NEWAM ResearchGate: https://www.researchgate.net/project/New-Wire-Additive-Manufacturing-NEWAM

Contact Information

Principal investigator: Prof. Stewart Williams (s.williams@cranfield.ac.uk)
Project manager: Dr. Sónia Meco (s.a.martinsmeco@cranfield.ac.uk)
Secretary: Anne Fiorucci (a.fiorucci@cranfield.ac.uk)
Newsletter coordinator: Dr. Yongle Sun (Yongle.Sun@cranfield.ac.uk)