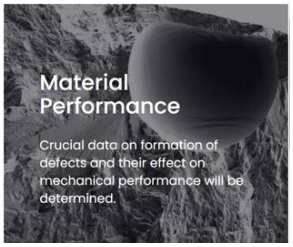
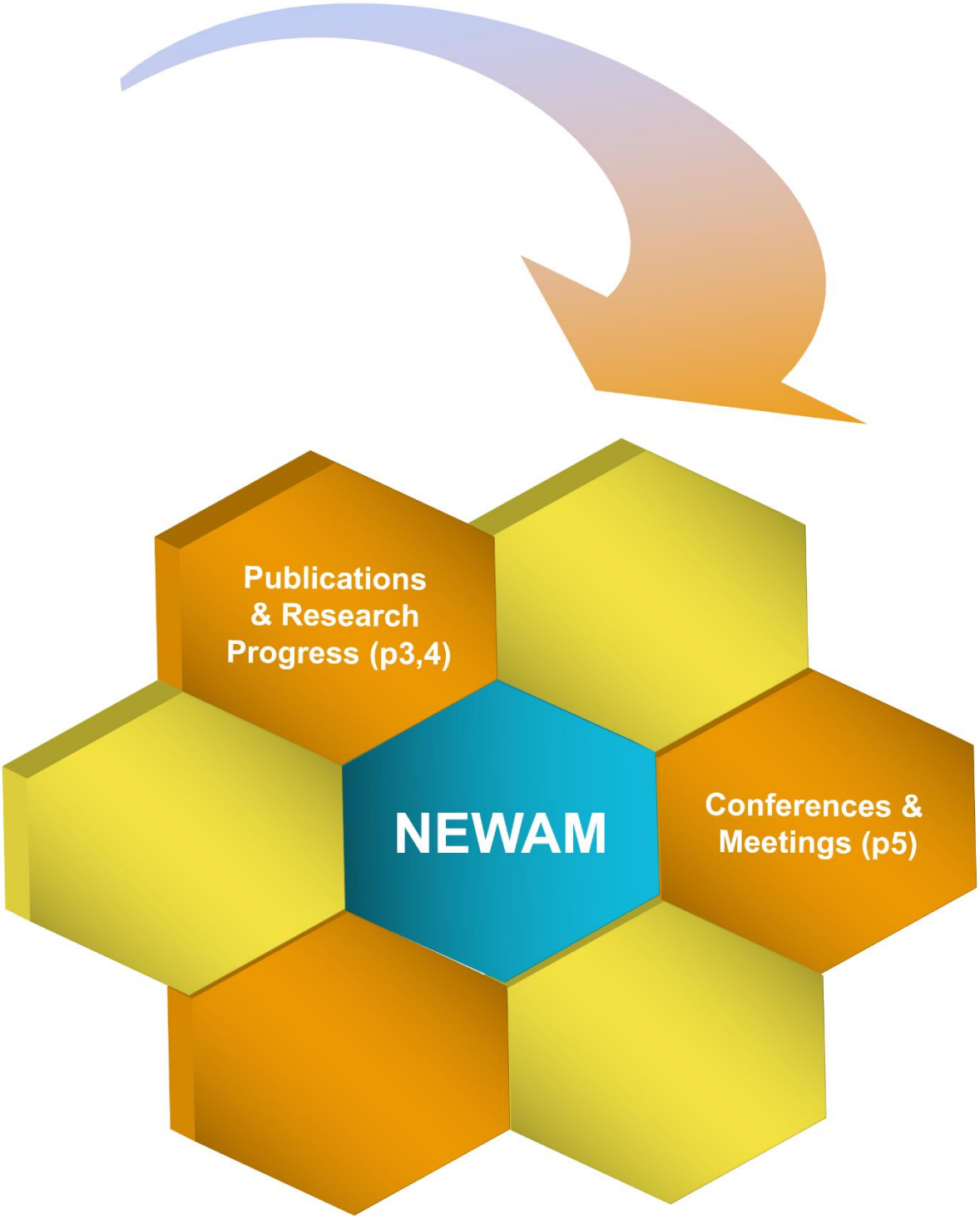
New Wire Additive Manufacturing

Newsletter (1st quarter, 2024)

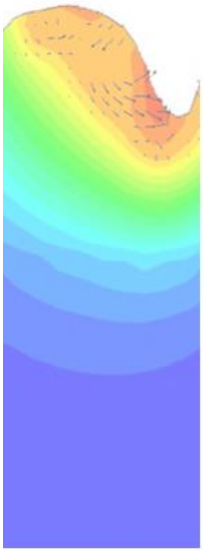


Compiled by NEWAM dissemination committee and released on 2 April 2024

NEWAM in January – March 2024



Publications & Research Progress



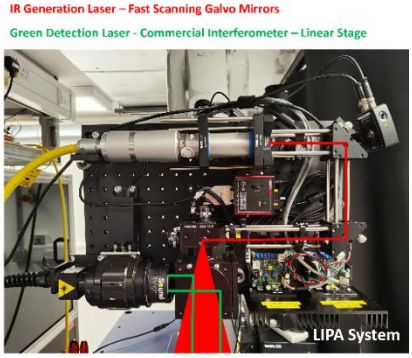
WAAM for producing aluminium lithium components

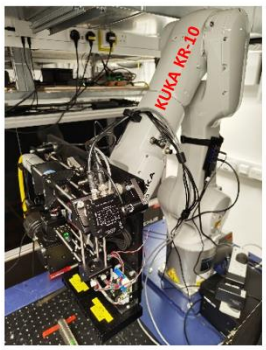
- Stewart, Jialuo and Eloise published a conference paper on the aluminium lithium work conducted through the IAWAS project.
- In 2022, Cranfield delivered a European project called Innovative Aluminium filler Wires for Aircraft Structures (IAWAS - ID: 821371). The project aimed to demonstrate the potential of Wire and Arc Additive Manufacture (WAAM) in producing aluminium lithium components. To achieve this goal, Cranfield received support from Coventry University through the NEWAM program.
- The Coventry team characterised the material and helped us understand its mechanical behaviour. The resulting paper reports on implementing in-situ alloying and inter-layer cold work to assess the impact of the chemical composition and grain structure on the material properties. The alloy and processing conditions were used to manufacture an aluminium lithium demonstrator that showcases the potential of WAAM in producing real-life components.

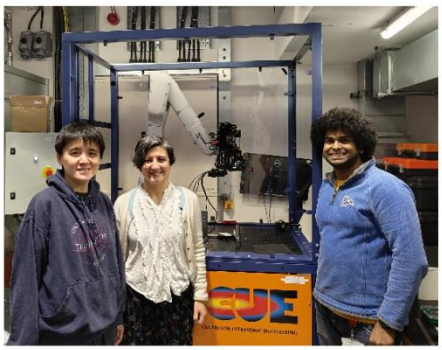
Eimer, E., Ding, J. and Williams, S., 2024. From Wire to Component: Aluminium Lithium Alloy Development for Wire and Arc Additive Manufacturing. BHM Berg-und Hüttenmännische Monatshefte, Volume 169, pages 9–16, (2024)

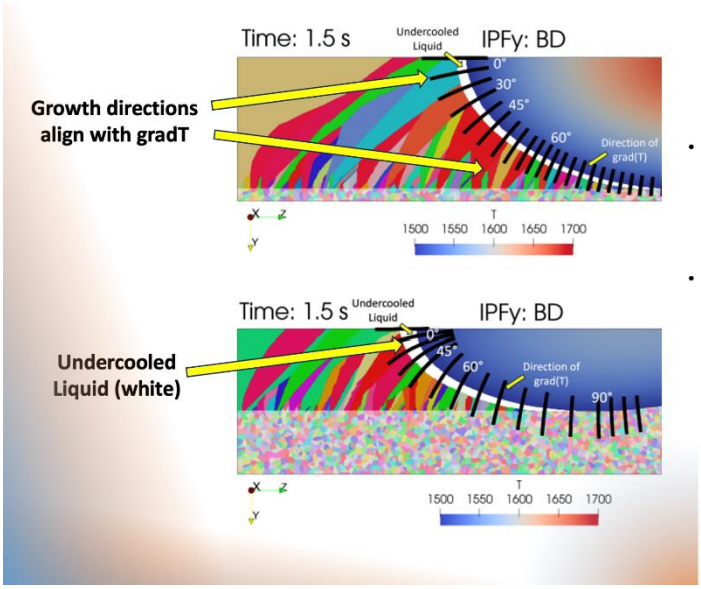
Robotic Implementation of Laser-Induced Phased Arrays at Strathclyde

- The Remote Ultrasonic Laser Enabled Sensing (RULES) team at Strathclyde has developed a compact, portable version of their Laser-Induced Phased Array (LIPA) system, specifically designed and built for robotic integration. This marks the initial prototype of a compact LIPA system, paving the way for further development of a small, modular system potentially available commercially for robotically delivered, in-process LIPA inspection of WAAM.
- The LIPA system was mounted onto a KUKA KR-10 robot and demonstrated its capability by acquiring data from the as-deposited surface of a WAAM sample at the NEWAM TRL workshop. Nevertheless, this system represents a significant advancement in LIPA capability as it enables the inspection of both large and complex geometries.







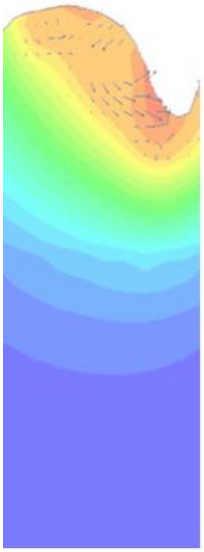


HEDSATS & CA Coupling:

Columnar grain growth aligns with local direction of thermal gradient

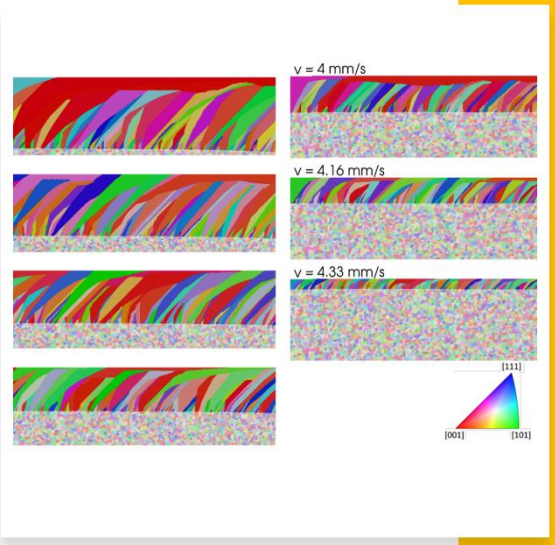
- The coupled CA & HEDSATS simulations for single track melts of SA508 steel beneath a moving double-ellipsoid heat source, were used to illustrate the tendency for the growth of columnar grain to become tilted towards the scanning direction in the upper regions of a layer.
- The local direction of the thermal gradient in the solidification zone is depicted by black lines, whose inclination angle reach maxima at the base of the melt pool where they are aligned with the build direction, and at the trailing edge of the melt pool where it is aligned with the build direction. As can be seen, the growth of columnar grains more or less align locally to the thermal gradient, with the inclination of the major axis of the high aspect ratio columnar grains becoming tilted towards the scanning direction. Additionally, the region of undercooled liquid is shown in white, which is larger towards the top of the melt pool, indicating that if a CET were to occur, it would most likely occur here.

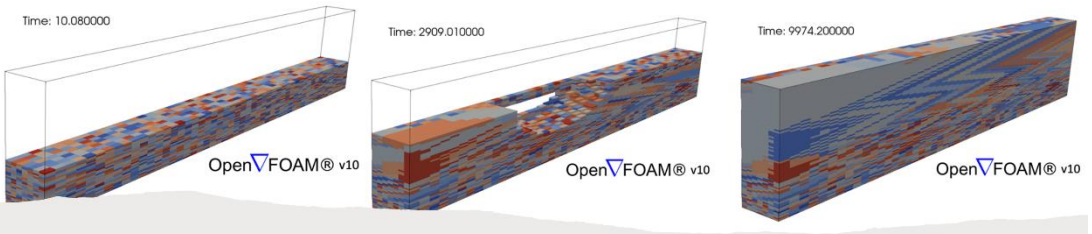
Publications & Research Progress



HEDSATS: Variation of Scan Velocity

- Increasing travel speed in additive manufacturing processes is crucial for improving overall productivity and cost-effectiveness. Faster travel speeds facilitate shorter production cycles, minimizing operational costs and addressing the time-intensive nature of additive manufacturing.
- The effect of increasing travel speed in the HEDSATS model on CA grain structure predictions are shown in the above figure where all parameters including the melt pool shape parameters were kept fixed, and only the scanning velocity was altered. As expected, increasing the scanning speed while keeping the input power constant results in a shallower melt pool due to the lowering of the energy density. Similar grain structure are observed as before, with local growth directions of columnar grains tilting towards the scanning direction at the top of the melt track.

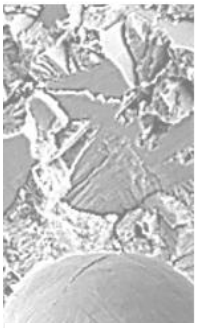


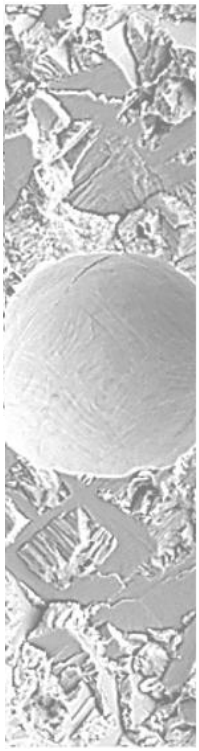


Abaqus FEM & CA Coupling – Extension to multiple layer

- The coupling scheme developed to link the thermal output of the WAAM FEM model developed at Cranfield and the CA grain structure prediction model has been extended to multiple layers, working towards our goal of prediction multi-layer prior beta Ti grain structures as part of the demonstrator.
- Shown above are just preliminary results that demonstrate that the coupling scheme works, although the grain structure predictions are invalid as the computational cells in the mesh are not uniform. Work is on-going to interpolate the thermal fields on to a fine, uniform mesh so that high resolution and valid grain structure predictions can be made, in the hopes that they match well with experimental microstructure of the real-world sample that is being characterised at Manchester.

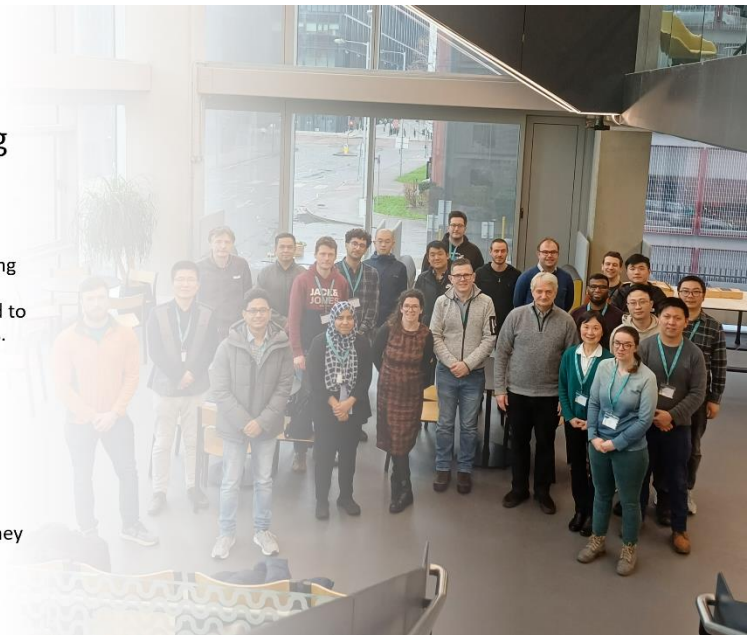
Conferences & Meetings



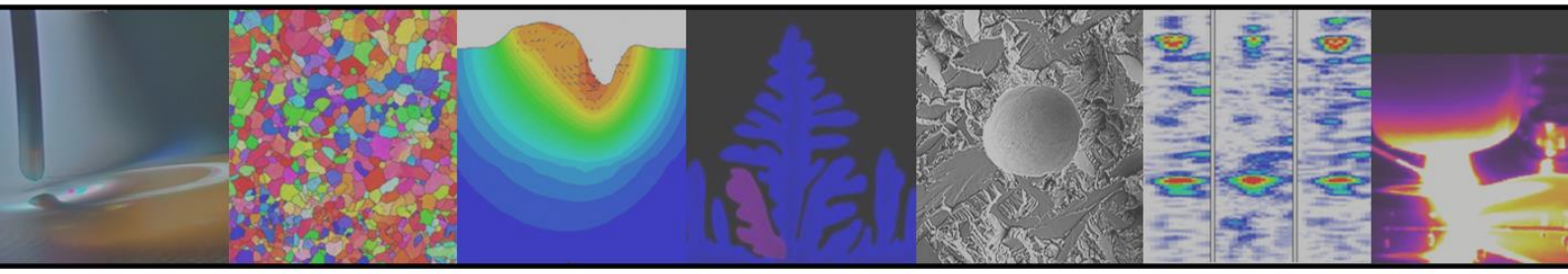


Last Consortium Meeting Held at Manchester

- The 16th NEWAM Consortium Meeting was the last informal team meeting where all the research team gathered to review and discuss the work progress.
- After nearly six years of continuous teamwork, we are very proud of our achievements: Discovery of new processes, models and theories; engaging with local schools, general public and industry; writing publications; and so on.
- We are nearly at the end of this journey but will soon start another one together.



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

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