

New Wire Additive Manufacturing

Newsletter (4th quarter, 2022)



Process Development
Developing new wire DED processes with the Multiple Energy Source (MES) approach



Process Modelling
Developing physics based process models for process design and understanding.



Process Monitoring
Developing advanced process monitoring techniques to measure the weld thermal profile and layer height.




Material Development
Developing new wire compositions of advanced microstructures



Material Modelling
Developing microstructure models to design bespoke materials and predict the process-property relationships



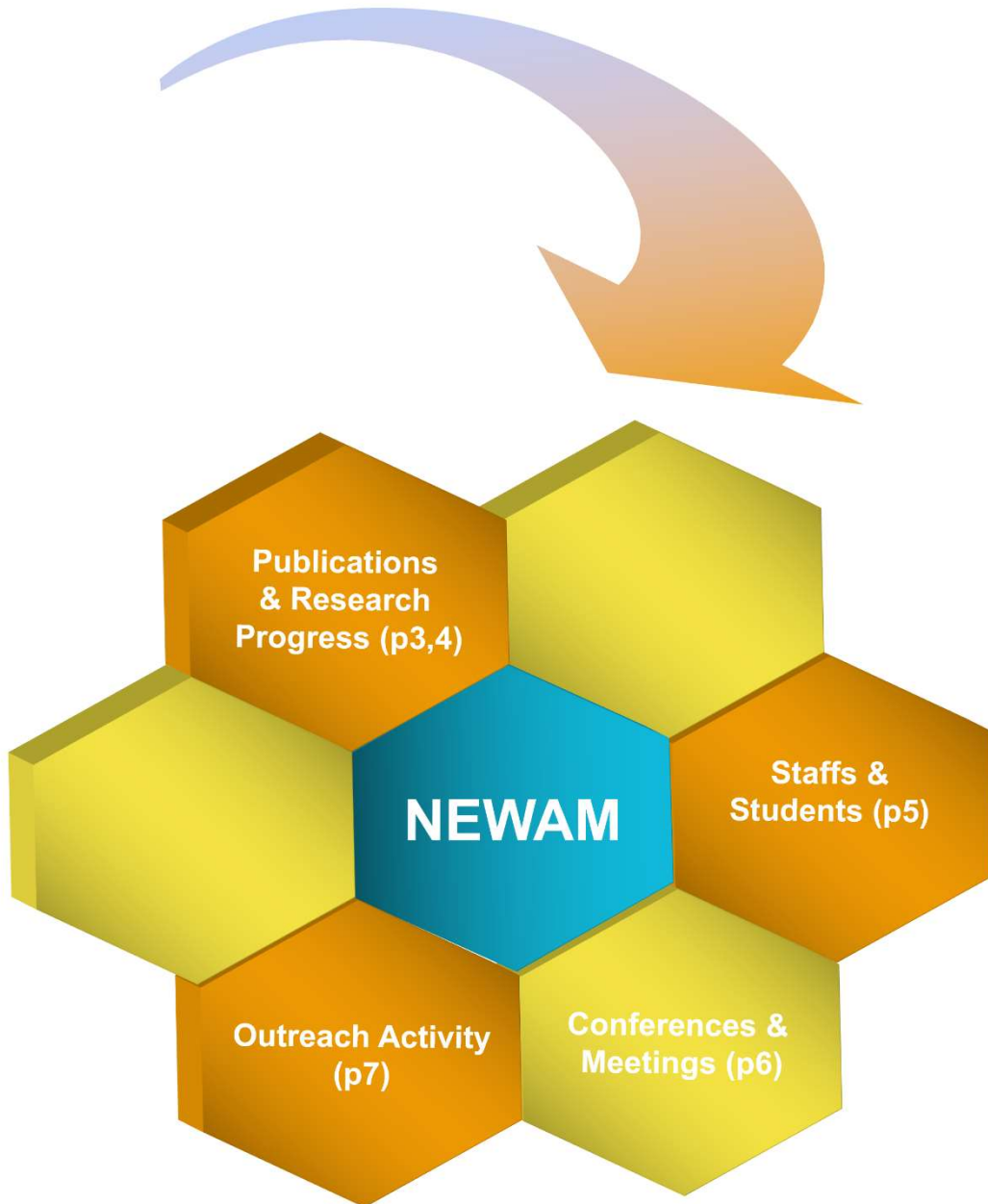
Non-Destructive Testing
Developing new in-process NDE techniques suitable for DED AM.



Material Performance
Crucial data on formation of defects and their effect on mechanical performance will be determined.

Compiled by NEWAM dissemination committee and released on 11 January 2023

Your NEWAM in October – December 2022





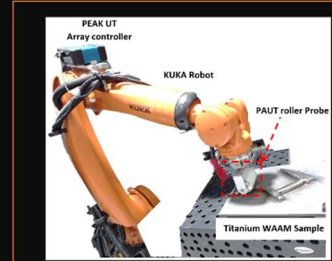
New Wire Additive Manufacturing

Publications & Research Progress

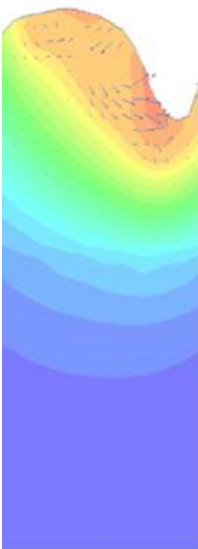


Automated, Hand-guided inspection of Complex Geometry WAAM components at Strathclyde

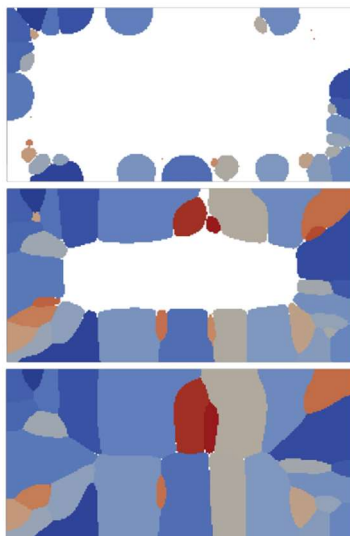
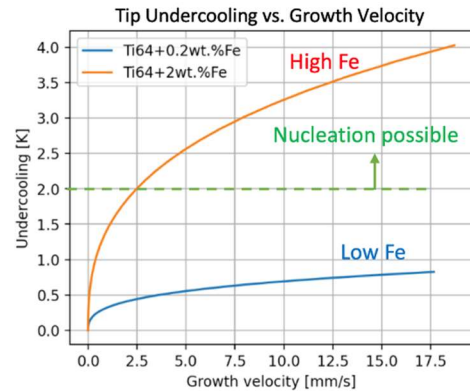
- An updated version of Force-torque sensor based real-time, hand-guided positional control of KUKA robot has been developed for the NDT sensor deployment at the Sensor Enabled Automation Robotics & Control Hub (SEARCH).
- The new motion control mechanism provides an intuitive & user-friendly path programming in complex 3D space in minutes. This enables an automated and efficient, high-temperature PAUT roller probe inspection of complex geometry wire + arc additive manufacture (WAAM) components, e.g., establishing an optimum ultrasound testing sensitivity at curved shaped walls, T-junctions, and varying wall thicknesses.



Dendrite Tip Kinetics Models have been applied to Ti-6Al-4V+xFe to estimate tip undercooling, and therefore likelihood of CET

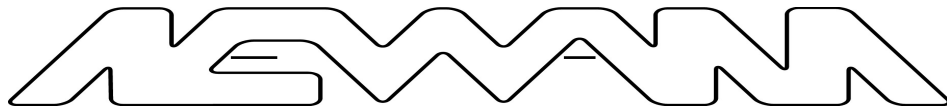


- Daniel Dreelan, a recent post-doc hire at Manchester has applied his dendrite tip kinetics models to investigate the effect that increasing the content of strong partitioning elements such as iron has on tip undercooling. It has been demonstrated that even impurity levels of iron can have a significant effect on slowing growth kinetics, increasing the tip undercooling.
- Higher tip undercoolings increase the likelihood for CET (columnar to equiaxed transition), and so this work is a useful tool in alloy development. Similar modelling work is being applied to support arguments in a paper by Dr. Alec Davis, that CET observed in WAAM is unlikely by classical thermal means.



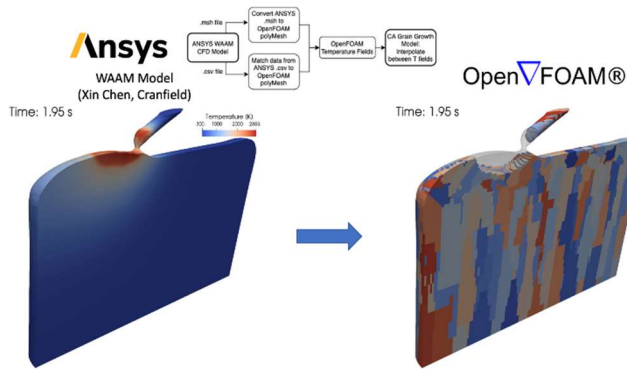
Manchester modelling team's Nucleation Model added to Isotropic Phase Field solver

- A nucleation model has been added to the Moelen's based isotropic phase field solver developed by Tom Flint and Daniel Dreelan, expanding its capabilities considerably. Now that nucleation is accounted for, it is possible to directly predict the mechanisms behind CET.
- Several efficiency improvements have also been made to the model, which will lend itself immensely to its applicability for large scale simulations. The software is intended to be publicly released accompanied by a SoftwareX paper in coming months.



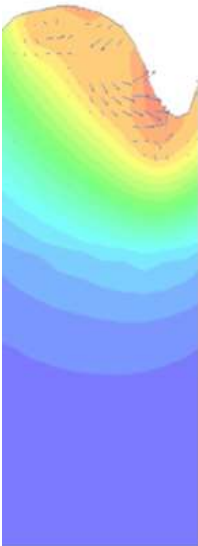
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Publications & Research Progress



Manchester microstructure modelling team coupled cellular automata grain growth model to Cranfield WAAM CFD model

- Daniel Dreelan's cellular automata grain growth models have been coupled to the WAAM CFD models of Xin Chen of Cranfield, which promises to provide a direct link between process, and solidification modelling.
- The work shown here is preliminary, and further work in this area continues, with the hope to extend it to multiple layers and various processing conditions.

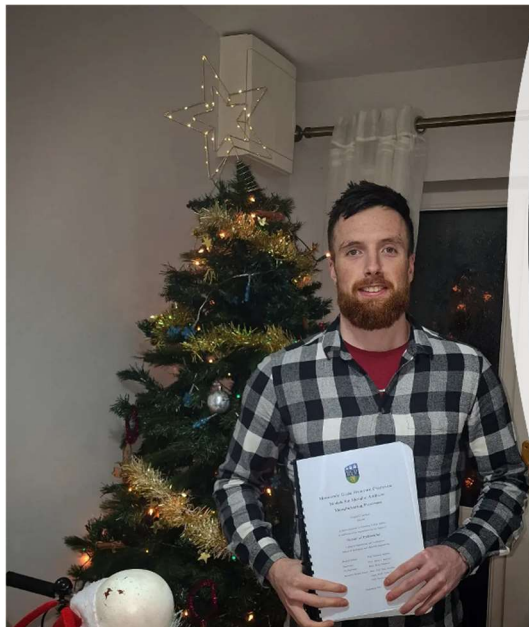


Staffs & Students



Dr. Sumana has started a new post in PEAK NDT Ltd as an NDT Research Specialist

- Dr. Sumana S has been successfully completing KTP tenure on 04/01/2023 and joining as NDT Research Specialist in PEAK NDT Ltd company, Derby.
- She joined the University of Strathclyde and PEAK NDT Ltd in January 2021, as a KTP Associate and has grown to an expert in developing next-generation ultrasonic imaging software development tools for future commercial deployment.
- **Project summary:** Sumana's project aims to understand and develop a focal law calculator for planar/nonplanar interface component compensation and inspection using phased array ultrasonics and also advanced Non-Planar Interface Imaging using LabVIEW software. The project investigated establishing ultrasonic wave propagation understanding, knowledge (wave frequency, velocity, refraction and attenuation) and compensation techniques (Focal Law Calculations and Post Processed FMC) in planar and non-planar surfaces and objects through simulation such as CIVA, and practical experimental work. The project also involved the design and development of reference non-planar complex calibration specimens. A key output of this stage is the initial architecture and development of a Focal Law Calculator, as well as development of Phased array GUI and interface with hardware.



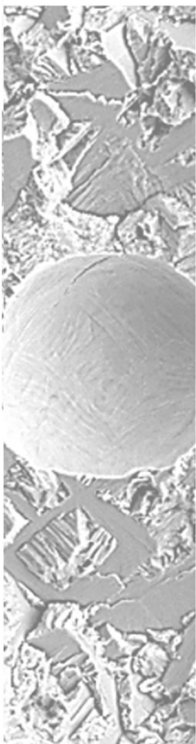
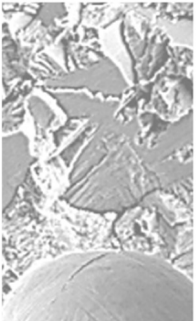
Daniel Dreelan has passed his PhD viva

- Daniel Dreelan, who has recently joined the NEWAM modelling team at Manchester under the supervision of Prof. Phil Prangnell, has just passed his PhD viva with minor revisions which have been addressed without issue.
- Daniel's work entitled "Meso-scale Grain Structure Prediction Models for Additive Manufacturing Processes", was focused on the development of cellular automata based grain nucleation and growth models that were mainly applied to the L-PBF process. During his new role within AM, his models are applied to WAAM processes.



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Conferences & Meetings



Professor Gareth Pierce was invited Speaker at the NDE session of ICAM (International Conference on Additive Manufacture), 30 Oct 2022—4 Nov 2022

Professor Pierce presented the “Developments of in-process NDE techniques for Wire + Arc Additive Manufacture at University of Strathclyde” by giving an overview of the research and development activities at the RoboWAAM, SEARCH and NMIS labo facilities of the NDE group.



Strathclyde team Submitted Abstract to Conference 2023

NEWAM team member, Rastislav Zimmermann, has submitted abstract to the 13th European Conference on Non-Destructive Testing (ECNDT), titled “In-process Non-Destructive Evaluation of Wire + Arc Additive Manufacture Components Using Ultrasound High-Temperature Dry-Coupled Roller-Probe”





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Outreach activity

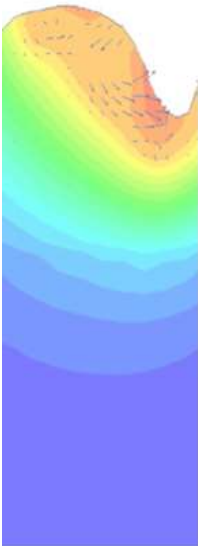


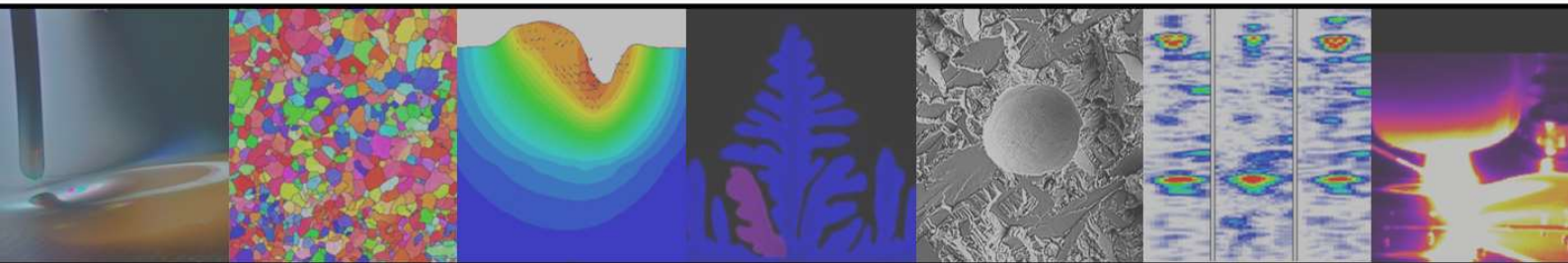
SCHOOL OUTREACH ACTIVITY – 1ST DECEMBER 2022

Last month, we were thrilled to be asked to host another school outreach activity, which took place at Cranfield University as part of the Manufacturing and Materials week 2022. The University looked at inviting a school that would benefit from a boost to its science provision.

A group of 45, Year 6 children (10 to 11 years old) from Bedford Road Primary School in Kempston was invited: they heard not only about how dissimilar materials like glass, concrete, metals and so on produce CO₂ emissions and the efforts to cut it, but also the importance of sustainability and how waste could be reduced, starting at home.

They liked our small scale 3D printer demo which was used to show how, in the real world, additive manufacturing works and how sustainable it is compared to other traditional manufacturing techniques and of course its impact on carbon emissions. In addition, the children very much enjoyed looking at close-up samples through a telescope, showing how this is used to check for defects.





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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