



ADVANCED TECHNOLOGIES FOR BATTERY LIFECYCLE MANAGEMENT

Cladding process optimization through process simulation and DOE

After several months of work, the second task of R3-MYDAS Oil & Gas Use Case is almost complete. This task has been structured in two main activities, each designed to deepen our understanding of the cladding process and its impact on the final component's performance.

Design of Experiments

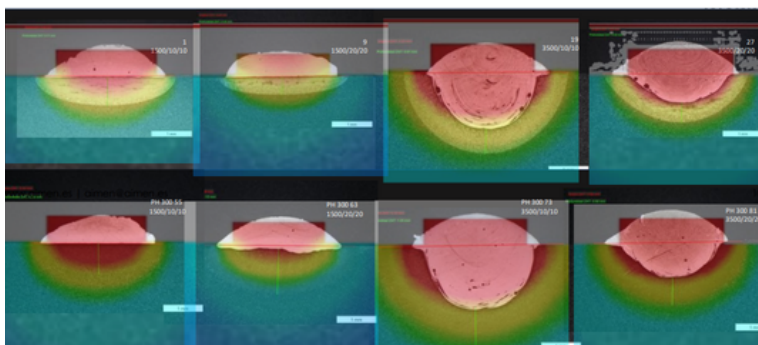
The first activity focuses on the development of and execution of comprehensive Design of Experiments (DOE).

The objective was to systematically study how key process parameters — laser power, scanning speed, preheating temperature and powder federate — influence critical responses of the deposited material. By varying these parameters within controlled ranges, we analyzed their effects on several measurable outputs, including hardness in the clad, HAZ, bead width, bead height, and more. This structured approach has provided valuable insights into the relationship between input conditions and resulting material properties.

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Cooling rate study – Towards reducing preheating requirements

In parallel, a dedicated study was carried out to investigate the relationship between cooling rates in the HAZ and the resulting hardness. This analysis aimed to identify the thermal conditions that directly affect microstructural evolution and mechanical performance.



The knowledge gained from the DOE and the cooling rate study will soon be consolidated into actionable guidelines for cladding process optimization. These outcomes will not only support the current case study but also provide a strong foundation for extending the methodology to other laser cladding applications.

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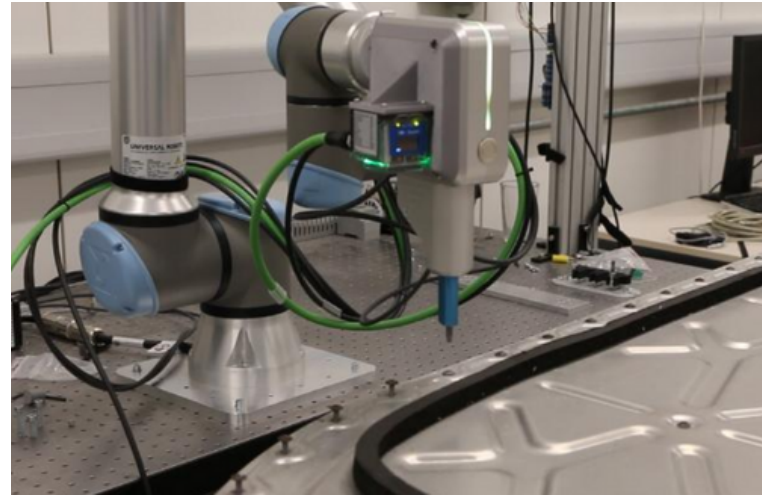
Robotics and Machine Learning for Remanufacturing

Among other tasks, R3-Mydas is focused on embedding robotics and machine learning into remanufacturing tasks, directly addressing performance and quality improvements across the project's use cases. Two key strands of work are under development: Cognitive Robotics for battery recycling and Quality Control for the laser cladding process.

Cognitive Robotics

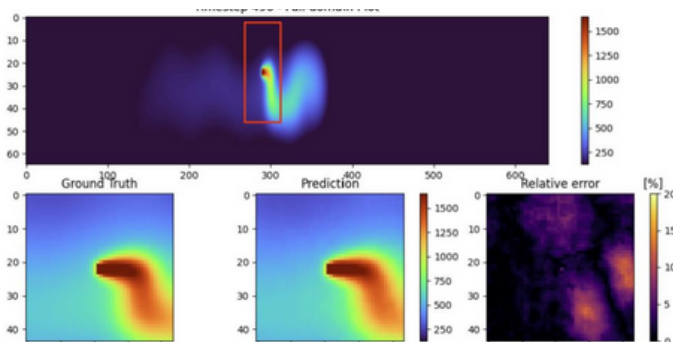
Following discussions among partners, SPIN provided a robotic screwdriver which was integrated into CSEM's Universal Robot arm, while AVL supplied a battery unit adapted for safe experimentation. With SPIN's low-level code examples, CSEM implemented functions enabling complete script-based control of the screwdriver.

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Quality Control in Laser Cladding

In parallel, a surrogate model is being created to accelerate process optimisation for laser cladding, with future potential for closed-loop control. The surrogate focuses on mapping process parameters such as laser power and scan speed to output predicted thermal behaviour.



A neural operator approach was selected for its ability to learn mappings across a wide range of geometries and scan paths. To support this, training data was produced with CIMNE's Add2Man software, which simulates part-scale 2D laser cladding processes across diverse trajectories and process conditions.

The simulation outputs were then processed through a dedicated data pipeline that structured the results into formats suitable for machine learning model training.

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Partners



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