Project Summary

June 2022

NWCAM

North West Centre for Advanced Manufacturing

Laser Prototypes Europe (LPE)

Company overview

Laser Prototypes Europe (LPE) is a Belfast-based 3D printing and additive manufacturing company with over 30 years' experience of delivering manufacturing solutions for customers in a wide range of industry sectors throughout the UK and Ireland. As a specialist in rapid prototyping and additive manufacturing technologies, LPE offers services such as stereolithography, selective laser sintering, metal sintering and vacuum casting.

The projects

- Development of process simulation models for metal laser sintering
- Development of advanced materials for additive manufacturing of medical devices and components
- Development of process simulation models for laser sintering and fused deposition modelling of polymers
- Optimisation of the laser sintering of metal parts for medical products

Industry focus

The main objective of the projects was to develop models and materials research to optimise the additive manufacturing process for biomedical grade titanium alloy parts made using Powder Bed Fusion technology (also known as laser sintering). Research explored the development of models to simulate additive manufacturing processes in metals. Detailed materials information was examined to understand the heat transfer processes in additive manufacturing and to accurately create 3D models.

As part of the research, the impact of additive manufacturing process parameters on the material in finished components was examined. Several investigative tools (including experimental characterisation and computer simulation techniques) were used to establish the influence of the powder, the machine, and the shape of the melt pool on the properties of the finished components.

The strand of research which focused on the development of process simulation models covered both laser sintering and additive technologies including modelling of polymers (one of the most commonly used materials in the 3D printing industry). Process simulation models can provide insight into the relationship between the structural integrity of the part and the printing conditions required to achieve good print quality. In order to gain a fundamental understanding of the effects of processing conditions on polymers, both amorphous and semi-crystalline polymers were studied. Modelling expertise in laser sintering is essential for the development and improvement of high quality, cost-effective manufacturing processes and materials.

Other research focused on maintaining the quality of the powder feedstock (which is often reused to improve the overall sustainability of the manufacturing process). Such information is critical in determining how many powder reuse cycles should be attempted before replacing or replenishing the baseline powder feedstock.

Research partnership

LPE was partnered with Ulster University's Centre for Engineering and Renewable Energy (CERE) at Magee and Advanced Future Materials & Manufacturing group in the School of Engineering at Jordanstown. The research team included five co-investigators, three research assistants, and four PhD researchers.

Project outputs

The collaborative R&D projects led to the increase of expertise in advanced materials and modelling related to the manufacturing process, and the development of 3D-printed samples and simulated models related to continuous fibre reinforced thermoplastic (CFRT) polymers.

With regards to the impact of additive manufacturing process parameters on the material in finished components, research confirmed that improper selection of parameters would lead to defects within the parts. The team investigated, and improved upon, current scientific literature for defect avoidance. The new methods developed within the project used advanced modelling techniques and experimental evidence to support the findings. The experimental evidence demonstrated that parts (specifically titanium alloy components) could be made with fewer defects than those made using standard industrial parameter sets. This unique evidence should help to guarantee quality within the additive manufacturing industry.

A thorough investigation was carried out into the impact of oxygen increases on the mechanical properties of additively manufactured titanium alloys. Research revealed that with each powder reuse cycle oxygen levels increase, and eventually levels exceed standard requirements. A deeper understanding of the relationship between the number of cycles and the impact of oxygen levels is crucial for maintaining a balance of sustainability and quality.

As LPE's knowledge of product performance properties has deepened and new modelling software has been introduced, factory operations have been enhanced and production savings realised.

Commercial opportunities are opening in current and new markets. Tom Walls, Managing Director at LPE, commented: "We have watched leading multinationals working with world-class academics to add value to their brand and now through NWCAM we are doing the same thing. I have given presentations to potential blue-chip customers in Switzerland, Germany and the Czech Republic and it gives us tremendous credibility when I tell them we are working with PhD students through NWCAM in the field of additive metal. The work the researchers at Ulster University are doing is aimed at the life and health sciences sector, but we are able to apply this research to other industry sectors that LPE works with, ranging from aerospace to F1. This research is truly helping us to become one of the leading experts in metal additive manufacturing."

Project benefits

- Access to academic R&D expertise and facilities
- Commencement of invention disclosure process and proof of concept investigations to determine commercialisation potential
- Cross-border collaboration between Ulster University (Jordanstown and Magee), Atlantic Technological University, Trinity College Dublin and other NWCAM partners to deepen the understanding of laser welding
- Development of two-way knowledge exchange between LPE and Ulster University
- Increased competitiveness of the life and health sciences sector through innovation
- Industry-related skills development of academic researchers
- Knowledge dissemination to the wider life and health sciences sector through academic publications and conference presentations
- Technology transfer from Ulster University to LPE
- Upskilling of LPE staff with regards to new production techniques in metal additive manufacturing and simulation modelling for additive manufacturing

Project legacy

Dr Shaun McFadden, Ulster University, commented on the work with LPE: "The research data generated through NWCAM has given LPE greater insight into how to optimise components and ensure the best quality. Understanding how the powder can be reused from different manufacturing runs significantly reduces the cost barriers associated with Powder Bed Fusion, allows LPE to develop reliable cost models for their processes, and offers a more sustainable practice in the long term. The NWCAM project has impacted the industry procedures with clear benefits for competitive costing, greater sustainability, and improved quality assurance."