AM-PLATFORM MEETING 2019

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ABSTRACTS

Accelerating AM aerospace component production-*Harald Egner -MTC*

DRAMA (Digital Reconfigurable Additive Manufacturing facilities for Aerospace) is a three year, £14.3m collaborative research project and part of the UK's Aerospace Technology Institute's (ATIs) programme, which started in November 2017. The consortium is led by the Manufacturing Technology Centre (MTC) and includes ATS, Autodesk, Granta Material Intelligence, Midlands Aerospace Alliance, NPL, Renishaw and the University of Birmingham

The project will help build a stronger AM supply chain for aerospace by developing a digital learning factory. The entire AM process chain will be digitally twinned, enabling the cost of process development to be de-risked by carrying it out in virtual environment. The facility will be reconfigurable, so that it can be tailored to fit the requirements of different users and to allow different hardware and software options to be trialled. During the three years of the project an additive manufacturing Knowledge Base will also be created, to allow faster adoption and implementation of this transformative technology by businesses.

AM for Energy sector- *Luc Aixala-CEA*

Additive Manufacturing is widely used now in medical and aeronautic sectors. For energy sector, large number of metallic parts are in production, mainly for gas turbines. But many other applications in energy are currently rising up efforts to benefit of AM technology: heat exchangers, hydrogen components, electrical engines, chemical reactors. The presentation will highlight energy market segmentation and will detail 2 examples of R&D work carried at CEA on additive manufacturing: FeSi3% for electric engine (optimized rotors), and CuCrZr alloy for induction components. Finally, CEA platforms in AM will be presented

Conditioning of powders for additive manufacturing- *Adriaan Spierings-INSPIRE*

The influence of powder quality on the LPBF process and part quality has been underestimated in the past. As part of the ConPAM project, the influences of various powder properties and factors on process and part quality is investigated. Based on this research, a physical tool for the conditioning of powders for the LPBF process is developed, considering also the powder recycling process. The project thereby contributes to a quality management system for the LPBF process chain.

Metrology in Additive Manufacture- *Prof. Mick Morris- AMBER Research Center*

Developments allow parts to be constructed as reproducibly and reliably as well as assessing of defects. There two stands of metrology can be described as in-process monitoring and post process non-destructive evaluation. The former technique is being actively developed by several metal laser powder bed fusion (LPBF) tool manufacturers, with companies already offering products to market. Typically, these methods utilise optical techniques to continually monitor the laser melt pool as the spot is scanned across the metal powder surface. The output tends to be semi-parametric at best, but nominally comparative; for example, continual reference - whist building/printing - to a reference standard output within a user defined margin of acceptability. Any deviations beyond this window are highlighted and mapped in the 2D laser scan layer, and a graphical representation can be interrogated upon completion of the process. Confirmatory evaluation can be carried out by micro computed tomography examination. 'Micro CT' is already established as the gold standard non-destructive test method of choice in additive manufacturing as it can facilitate quantitative overlay 'heat' mapping of design versus built dimensional characteristics. In addition, µCT can be used to map internal deviations provided they contrast sufficiently to be imaged. Size and size distribution metrics can be extracted from this graphical information. X-Ray microscopy (which utilises optical magnification in addition to baseline geometric magnification) can also be used to determine internal deviations to structure, and in addition it may be also able to provide phase contrast information, in stances where X-ray contrast is not sufficient alone to provide good qualitative information.

By extracting in-process monitoring information in combination with X-ray NDT information, printing process parameters, iterative improvements can be made to the design and printing strategy on subsequent runs. Such 'correlative' engineering in data-rich, and there is an industry shift towards implementing so-called 'adaptive control' strategies during printing to negate the effects of topology drift and defect instance. Recent examples of metrology development are discussed here and how other techniques can be used to provide rich information on parts fabricated.

Application of machine learning techniques in additive manufacturing: trends and challenges- *Ivanna Baturynska-NTNU*

Machine Learning techniques are mainly used in the fields of study that work with complex tasks like quality assurance of the produced parts. Some of the examples are industrial robotics, real-time prediction of tool wear in traditional manufacturing and detection of the defects in produced parts. Application of such techniques like Artificial Neural Networks has a big potential in additive manufacturing as well. Researchers from all over the world are looking at the combination of AI and AM as a new way of utilizing AM technologies in more sustainable way. Additionally, machine learning techniques are well-known for their ability of finding hidden patterns in the data that cannot be seen with a 'human eye', and thus predict desired outcome with a better accuracy. Since, AM is a cross-disciplinary research area, usually involved disciplines are described separately from each other. For instance, material side is often represented as one separate island, while process is another separate island. However, application of machine learning can help us to connect these two islands into one land. There are a number of published works about application of machine learning in AM, but most of these works show a lack of understanding how it should be used and which requirements and limitations these techniques have. Additionally, the combination of machine learning and additive manufacturing in USA has been included it in their strategy (NIST has started working in this direction). Practical examples when machine learning works well for quality assurance in AM will be shown.

SLM cooling channels' surface finishing by AFM- *Nathalie Maillol-IPC*

The Selective Laser Melting (SLM) additive manufacturing technology of metal powder allows the creation of parts with high geometric complexity and/or integrating thermal management channels impossible to obtain with conventional subtractive technologies (machining, EDM, die sinking, …). Parts obtained by SLM must undergo different post-process steps because the mechanical properties are often not acceptable for real applications. Indeed, the heat treatment are mandatory after SLM to reduce the internal stresses created by the high thermal gradients (if it is possible) depending on the material, reduce the anisotropy inevitable because of the layer by layer manufacturing and enhance the material properties depending on the future applications. In addition, the roughness and the accuracy of the SLM parts do not allow to be integrated in assemblies with other machined parts. IPC is specialized in realizing mold insert for plastic injection by additive manufacturing.

The SLM additive manufacturing technology has a wider design freedom to include thermal regulation channels with very complex shapes to manage the tooling temperature and finally reduce the global cycle time thank to a faster cooling due to the proximity between the channels and the molding surface. One other benefit of the conformal cooling will be a reduction of the part warping and shrinkage due to temperature difference thank**s** to the thermal homogeneity in the mold insert. It is very important to consider the fact that the cooling channels placed as close as possible from the molding surface represent a mechanical weakness that has to be considered during the mechanical design. Indeed, the injection pressure applied during the plastic part production can reach 2 000 bar for plastic packaging.

The MELTED project is a French regional funded project working on the finishing of the complex cooling channels (inaccessible to conventional machining or subtractive technologies) thanks to the Abrasive Flow Machining (AFM) process which consists on extruding an abrasive paste through the channels in order to reduce and homogenize the roughness and decrease the internal tensile stresses. By polishing the channels, the fatigue resistance of the channels will increase and it will be possible to realize more parts with the same tool or to decrease the distance between the channels and the molding surface in order to decrease the cooling time.