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DIRECT LASER METAL DEPOSITION AND INDUSTRIAL APPLICATION

Jamaludin, J. *, Suhaimi, M.A.
Faculty of Mechanical Engineering, Universiti Teknologi Malaysia,
81310 UTM Johor Bahru, Johor, Malaysia.
* Corresponding author: jailani89@graduate.utm.my

ABSTRACT

Additive Manufacturing (AM) techniques have gained widespread recognition as the prospective frontier of the manufacturing industry owing to their remarkable potential in shaping design, enhancing part functionality, and optimizing material utilization. Although every AM process possesses its own set of advantages and disadvantages, the Directed Energy Deposition (DED) process stands out as especially well-suited for fabricating metal components. Directed Laser Metal Deposition (DLMD), represents a form of DED that harnesses a laser beam as a heat source to selectively melt and fuse metal powder. This process entails the continuous delivery of metal powder into a molten pool generated by the laser beam, which is subsequently deposited onto a substrate, thereby giving rise to a solid component. Hence, this paper focuses on two principal areas, namely, repair, and production, highlighting their significance and potential within the field.

KEYWORD

3D printing, AM, DED, DLMD, Rapid Prototyping

INTRODUCTION

Additive manufacturing, commonly known as 3D printing, primarily refers to a process that enables the rapid creation of product layers, finding extensive application across various industries. Total of seven group can be categorized for AM (Figure 1) and one notable advantage of the DED process, in comparison to other techniques, is its ability to align the substrate with the surface of an already existing component for metal components.

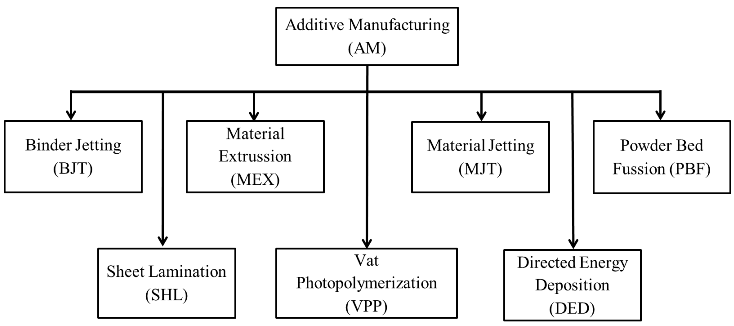


Figure 1: General additive manufacturing group according to ISO/ASTM 52900:2021.

The DLMD which under DED process involves the utilization of a focused laser beam to generate a melt pool on a substrate or building platform. Subsequently, a nozzle or deposition head is employed to introduce powder material into the formed melt pool, utilizing a carrier gas.

DLMD IN REPAIR SECTOR

Due to its high precision and minimal distortion impact on repaired components, the DLMD process has proven to yield satisfactory results in terms of dimensional accuracy and metallurgical bonding. As a result, it has emerged as the preferred repair process within the aerospace sector. Gasser et al (2010) use the technology repairing the damping wire grooves of a BR715 HPC front dump made of Ti6Al4V alloy jet engine from Rolls-Royce (Figure 2).

In a study conducted by Bennett et al (2019) an automotive steel die, depicted in Figure 3(a), and was successfully repaired. The repaired die, as depicted in Figure 3(b), exhibited a comparable lifespan to that of the original die. Another successful repaired was done by Koehler et al (2010) where A marine diesel engine crankshaft was repaired (Figure 4).

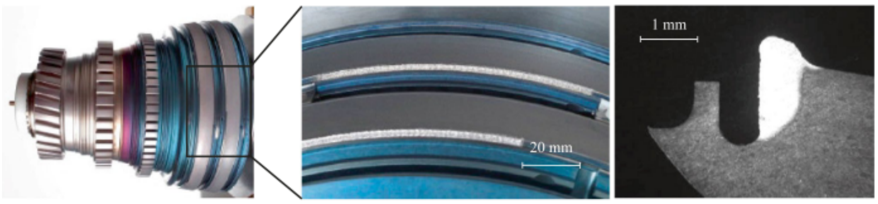
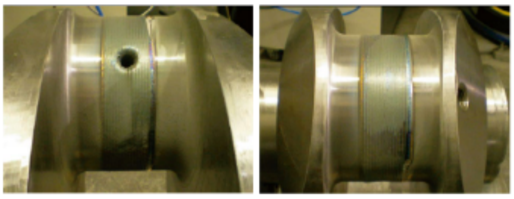


Figure 2: Ti6Al4V groove wall repair using DLMD process (Gasser et al, 2010).

(a) (b)
Figure 3: Automotive steel die (a) damaged and (b) restored (Bennett et al, 2019).


(a) (b)
Figure 4: Diesel crankshaft (a) damaged and (b) repaired (Koehler et al, 2010).

DLMD IN MANUFACTURING SECTOR

One of the key advantages of DLMD process is the ability to produce near net shape components without the need for traditional tools and moulds. This eliminates the reliance on costly and time-consuming tooling processes, allowing for more efficient and flexible manufacturing of complex parts. The renowned company DMG Mori successfully manufactured a stainless steel turbine housing (Fig. 5) using the DLMD technology.

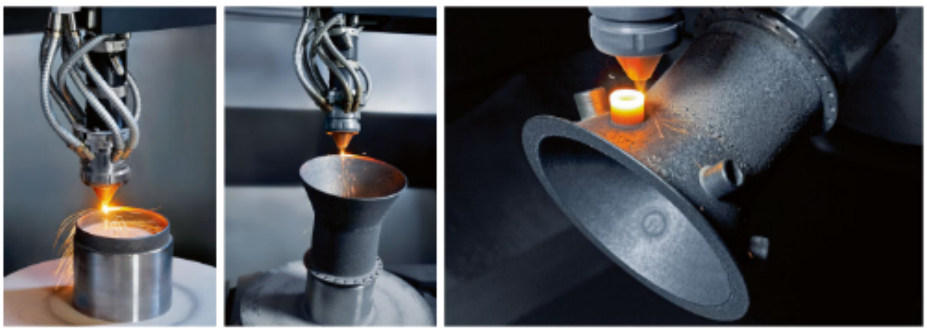


Figure 5: Production of a stainless steel turbine housing (courtesy of DMG Mori).

Additionally, The Welding Institute (TWI) also achieved success in creating an Inconel 718 helicopter engine combustion chamber (Fig. 6) through the utilization of DLMD.

Figure 6: Production of IN718 helicopter engine combustion chamber (courtesy of TWI).

CONCLUSION

In conclusion, an observation made indicates that the primary application of DLMD is focused on repair operations involving high-value components that possess intricate shapes. Examples of such components include turbine blades and various engine parts. Moreover, the DLMD process is utilized for producing near net shape of parts that exhibit relatively straightforward geometry and large dimensions. Overall, the application possibilities of DLMD are extensive and offer a wide range of opportunities for exploration and development.

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TWI https:// www. twi- global. com/