Chapter 8
Laser Additive Manufacturing

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ABSTRACT

Laser additive manufacturing is an advanced manufacturing process for making prototypes as well as functional parts directly from the three dimensional (3D) Computer-Aided Design (CAD) model of the part and the parts are built up adding materials layer after layer, until the part is competed. Of all the additive manufacturing process, laser additive manufacturing is more favoured because of the advantages that laser offers. Laser is characterized by collimated linear beam that can be accurately controlled. This chapter brings to light, the various laser additive manufacturing technologies such as: - selective laser sintering and melting, stereolithography and laser metal deposition. Each of these laser additive manufacturing technologies are described with their merits and demerits as well as their areas of applications. Properties of some of the parts produced through these processes are also reviewed in this chapter.

1. INTRODUCTION

Laser is an important technology with exciting properties that makes it highly valued in most human endeavor. The importance of laser in engineering in general cannot be over emphasized and in material processing in particular is phenomenal. Some important characteristics and types of lasers used in material processing are discussed in this chapter. The use of laser in material processing and in additive manufacturing is revolutionary. Additive manufacturing is an advance manufacturing process that is used to fabricate three dimensional (3D) parts directly from the 3D computer aided design (CAD) model of the part to be produced simply by adding materials layer after layer until the building of the part is completed (Scott et al., 2012; Mahamood et al., 2014a). A number of additive manufacturing technologies use laser as their energy source and they are called laser additive manufacturing (LAM) processes. The laser additive manufacturing uses the energy from the laser to process materials due to the exciting properties of the laser that enables the laser beam to be effectively controlled for the intended manufac-

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turing operation. Some of the laser additive manufacturing technologies are discussed in this chapter. There merits and demerits are also highlighted, and their area of applications are mentioned. The chapter ends with summary and the future research directions of the laser additive manufacturing processes.

1.1. Lasers in Material Processing

Laser is an acronym that is used to describe the technology of Laser. LASER stands for Light Amplification by Simulated Emission of Radiation (Haken, 1983). The laser is generated from the light source which is then amplified in such a way that is similar to the way microphone amplifies sound. The amplification of the light is achieved by a process that is known as simulated emission; it is also referred to as optical amplification (Yamashita et al., 2007). The rays of light that are emitted from a single light source are used to create an excitation in the atoms that are present in the lasing medium or the gain amplification medium which could be in form of solid, liquid or gas (e.g. Co_2). The atoms in these lasing media get excited and they emit a coherent type of light rays. The amplification is achieved through the arrangement of mirrors in the gain chamber. The excited atoms bounce back and forth between these mirrors thereby resulting in a powerful amplified coherent beam of light rays that is called 'Laser' (Haken, 1983; Silfvast, 1996). Imagine placing an object in between two parallel mirrors, the image of the object will bounce back and forth and the numbers of images that is produced as seen in the mirrors becomes uncountable (see Figure 1a.). This is what is referred to as an optical amplification that has generated countless images of a single object placed between two mirrors. This same principle happens when a single light source is placed in between two parallel mirrors. The Laser light is characterized by a single wavelength that is known as monochromaticity; the light from laser usually comes from one atomic transition with a single precise wavelength which gives the laser light a single spectral color and it is almost the purest monochromatic light available (Ambroseo, 2001). Coherency, also known as same phase position and low divergence (they spread out in parallel lines) are other important characteristics of laser (Haken, 1983). All these characteristics contribute to the higher intensity of the laser beam as compared to other light sources and thereby allowing the concentration of all the intensity at a particular point of interest.

1.2. Classification of Lasers

Laser can be classified based on the mode of operation. It can either be operated in a continuous wave (CW) mode or in a pulsed mode (Paschotta, 2008). Continuous wave mode operated laser are operated at a constant power output over a length period of time. The Laser can also be operated in a pulsed mode such that the output power appears in pulses for a certain length of time and also repeatedly over a period of time. The pulsed laser may be used where a large power is required for a very short length of time. An example of an application where the pulse laser is desirable is in the laser ablation process (Powell, 1993). In laser ablation process, the high power is required to melt and evaporate a small portion of material in a very short length of time without transferring the heat generated during the process from the point of ablation to the bulk material. On the other hand, the continuous wave laser is used in applications that required a constant power over a period of time. There are different types of lasers and they are discussed in the next sub section.

Related Content