Chapter 13
The Role of Self-Assembly in Additive Manufacturing of Aerospace Applications

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ABSTRACT

Additive manufacturing is a strategy to produce parts with complex geometries whose process is prohibitive in cost or impossible through subtractive or formative techniques. Research groups are optimizing additive manufacturing processes to improve their performance and reduce the cost of aerospace parts. One of the emerging design techniques is self-assembly which seeks to reduce the number of parts to produce best design practices and rules. Self-assembly represents a comprehensive strategy that improves process time, product quality, cost of materials, and printability. The purpose of this chapter is to review the technological contributions that self-assembly has had in the additive manufacturing of aerospace parts. Future perspectives of the role of self-assembly in additive manufacturing are proposed. According to what was found in this research, self-assembly will facilitate the additive manufacturing of parts in various technological sectors where the manufacture of lightweight parts with high added value and restrictive regulations are required.

INTRODUCTION

In the search for techniques and technologies for the low-volume production of innovative, customized, and sustainable products, the manufacturing industry has introduced additive manufacturing in the last decades (Uriondo, 2015). Additive manufacturing is the process of joining materials to produce objects from three-dimensional model data that are additively placed layer upon layer. It is regularly used to make rapid prototypes, but thanks to the optimization of processes and material properties, it is now feasible to build aerospace parts for direct assembly purposes to systems operating in the field. Until now many techniques applied in additive manufacturing have been developed, such as stereolithography (SL), inkjet

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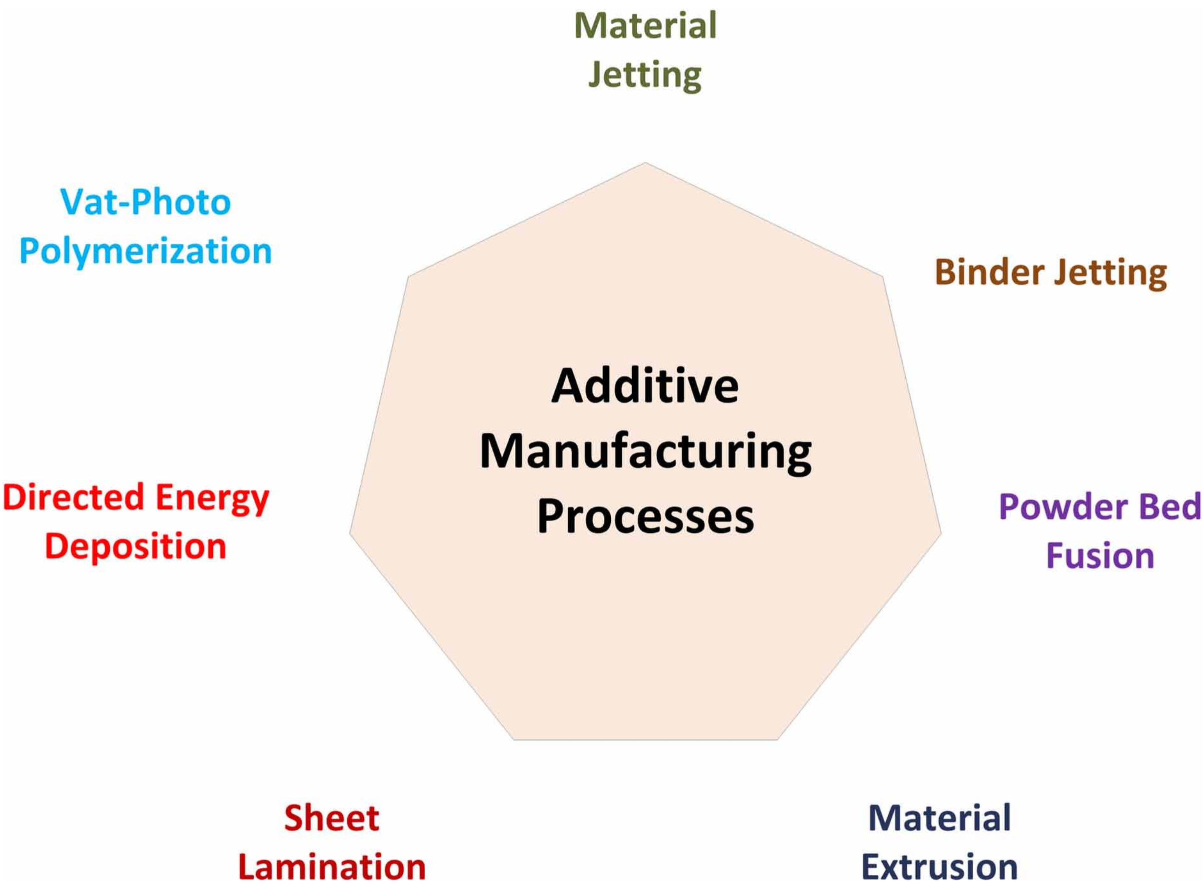
printing (IJP), fused deposition modeling (FDM), selective laser sintering (SLS), selective laser melting (SLM), electron beam melting (EBM), direct metal deposition (DMD), among others, as shown in Figure 1. However, not all of them can produce metal parts. SLS, SLM, laser metal deposition (LMD), EBM, and wire and arc additive manufacturing (WAAM) processes are the most versatile processes for producing complex functional and metallic components to meet stringent requirements from the aerospace industry (Herzog, 2016; Ligon, 2017; Yusuf, 2019; Sanchez-Rexach, 2020; Alghamdi, 2021).

Figure 1. Additive manufacturing processes



The aerospace industry consists of different players including original equipment manufacturers (OEMs), maintenance, repair, and overhaul (MRO) organizations, and commercial aerospace operators (CAOs) (Singamneni, 2019). In the manufacturing process, aircraft parts manufacturers such as Boeing, Airbus, GE Aviation, Lockheed Martin, BAE Systems, and Rolls-Royce Holdings are the main interested in bringing additive manufacturing to certification standards. Aerospace components consist of many parts, but their demand is unpredictable as they replace dispersed parts required only in scheduled or unscheduled maintenance events. This brings inventory levels to the limit of 10% for spare parts, which results in unpredictable exchange times and makes them expensive. Replacement parts are of four types: rotatable, repairable, expendable, and consumable. Each type has a different replacement policy. The