Chapter 13
Development of High Performance Polymer Composites by Additive Manufacturing

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ABSTRACT

Additive manufacturing, often known as 3D printing, is a process that involves the manufacture of physical things in a manner that is similar to building them up layer by layer. As a result of its utilization of automated procedures to generate complicated three-dimensional forms, which are either difficult or impossible to produce using conventional methods, fused deposition modeling is a typical approach that uses heat to assist in the extrusion process. The term "high-performance polymer" refers to a group of polymer materials that are known to maintain their desirable mechanical, thermal, and chemical properties when subjected to harsh environments such as high temperatures, high pressures, and corrosive chemicals. This chapter starts off with a brief introduction of conductive and high-performance polymer composites, followed by a rundown of how these materials are utilized in the 3D printing process.

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INTRODUCTION

The process of producing goods is being revolutionized by the additive manufacturing (AM) technique. Inkjet printing introduced the idea of additive manufacturing processes in the 1970s, but it wasn't until the 1980s that stereo lithography, a method for printing materials rather than ink, became widely used. Charles Hull's invention of stereo lithography allowed for 3D printing, which helped firms reduce time, cost, and resources. Since then, high-performing polymer nanocomposites have been printed using novel materials and additive manufacturing technologies. Although in case of any confusion, this was first required to distinguish between the phrases "additive manufacturing," "rapid prototyping," and "3D printing" before continuing on to the rest of the paper. Background information about this industry's present state and anticipated future expansion is also given (Infographic: The History of 3D Printing, 2016).

Additive manufacturing describes the procedure of layer-by-layer addition and connecting of materials to create a component. On the contrary, subtractive manufacturing involves removing matter from bulk in order to shape the expected results. The capacity of additive manufacturing to accurately construct more complicated structures than subtractive manufacturing is a key benefit (J.Stansbury et al, 2015). Rapid prototyping, on the other side, is "a method for quickly producing systems or component representation preceding final launch or commercialization (I. Gibson et al, 2015)," according to the definition. In other terms, rapid prototyping can be viewed as a particular kind of additive manufacturing process. additive manufacturing and 3D printing are being used alternately. And although additive manufacturing is frequently seen as a much more professional term, they have the same meaning.

Additive manufacturing is expected to keep expanding in the coming decades. According to the International Data Corporation, with the compound annual growth of 26.50 percent, "the almost 11 billion dollars' sector in 2014 will inflate to 26.70 billion dollars by 2018". West Europe, Asia, and the U.S.A are the countries that are fueling this increase (Worldwide Spending on 3D Printing to Grow from Nearly $11 Billion to $26.7 Billion by 2019, 2016). In addition, this long-established method that has typically been employed for rapid prototyping can now model consisting, of finished components (A Third Industrial Revolution, 2016) in addition to the numerous purposes it now fulfills (as shown in Figure 1) (Roundup of 3D Printing Market Forecasts and Estimates, 2016). Industrial equipment, consumables, and the automobile industries, particularly passenger vehicles, are the two main sectors of additive manufacturing as of 2015 (Figure 2) (Manufacturing Our 3D Future, 2016). The National Aeronautic and Space Administration, the European Space Administration, and the China space administrations were listed as important stakeholders in the developing markets for manufacturing body tissues. Regarding their LEAP fighter jet in specifically, General Electronic Aviation has created a 3D printed fueling nozzle. Although National Aeronautic and Space Administration, in partnership with Manufactured in Space, has indeed launched a 3D printing machine to the International Space Station (Additive Manufacturing State of the Industry, 2016), they assert that this component is "approximately to twenty-five percent lighter and much more complicated than any of its counterparts and integrates within one component what was numerous combined components in the previous (GE Aviation: Additive Manufacturing, 2016). The European Space Agency (www.Ptonline.Com/Articles/Additive-Manufacturing-Materials-for-Real-Worldparts2014, 2014) experiences the very same thing. In the meantime, CASTC is working to create a metallic 3D printing machine that might function in space. But it's crucial to note that most of these high-performance 3d printing technology components, particularly those for the automobile and aviation sectors, are composed of metallic elements.