Chapter 5
Additive Manufacturing for Sustainable Use of Resources

Joan Nyika
https://orcid.org/0000-0001-8300-6990
University of Johannesburg, South Africa

Megersa Olumana Dinka
https://orcid.org/0000-0003-3032-7672
University of Johannesburg, South Africa

ABSTRACT

This chapter explored ways in which additive manufacturing can be incorporated to enable sustainable manufacturing. Findings showed that the technology has the capacity to enable efficient use of natural resources, reduce waste production, and prevent environmental pollution. 3D printing is additive rather than subtractive and hence optimizes on the use of raw materials to only manufacture products when needed by customers with less wastage, which results to reduced resource use. The process is less energy consuming, produces less emissions and less waste compared to conventional machining and tooling processes. Additionally, the technology can use biodegradable filament as input or reuse and recycle metals and polymers for waste and pollution avoidance. Additive manufacturing however requires optimization through research, design enhancement, improved circularity of its inputs, and comprehensive life cycle assessment of its production processes to be more sustainable.

INTRODUCTION

In the contemporary world, industrial metabolism, which refers to the conversion of energy, natural resources, different forms of matter and labour to goods and services and other by-products such as emissions and wastes is on the rise (Peng et al., 2018). The concern on the use of conventional manufacturing activities of modern day (subtractive manufacturing involving machining, tooling, and moulding), which result to massive emissions and waste production that in turn cause environmental health and sustainability challenges is growing (Javaid et al., 2021). According to the International Energy Agency

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(2012), the industrial sector energy share use was more than 22% of the total share in 2012. The trend is likely to affect the use of natural resources whose nature is finite.

For this reason, there is great advocacy to adopt to advanced manufacturing techniques that are not only resource and cost efficient but also green, personalized, prioritize presumption and servitisation (Ford & Despeisse, 2016). Additive manufacturing (AM) or 3-dimensional (3-D) printing technologies is one such technology whose application is growing and thought to be transformative towards green industrialization trends. According to Gebler et al. (2014), AM will herald the future of industries through localized, shorter, smaller, more collaborative, and sustainable value chains. AM processes aim at producing customised products from data, made through layer addition, with less wastage and more precision unlike previous industrial techniques that were subtractive (Nyika et al., 2022 a, b). 3-D technology is relatively new and hence, the need to study the technique further to ascertain ways in which it can be improved towards sustainable use of resources especially those of finite nature (Mani et al., 2014; Ford & Despeisse, 2016). In this chapter, AM technology is explored and ways in which it can be infused into the principles of sustainable resource use particularly reduce, reuse and recycling. Therefore, the aim of the chapter is to explain ways of utilizing AM technology for sustainable use and management of resources especially those of natural origin.

Types of AM Technologies

AM technology works by beginning with a digital file of a designed object either as a 3-D scanning output or a computer aided design (CAD) file as the input. Other input materials that are used along with the file to produce the physical object include 3-D powder or wire (filament). Using the technology, advanced prototypes are applied to melt and print spare parts, medical accessories, food, and metals in a process that is rapid compared to conventional manufacturing (Jiang et al., 2021). The technology is also used at domestic level to manufacture low-cost products using techniques such as fused deposition modelling (FDM) and polylactic acid (PLA) as well as acrylonitrile butadiene styrene (ABS) polymers.