Additive Manufacturing of a Novel Cr-Ni Alloy using the Bound Metal Deposition Technique

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Abstract

Additive Manufacturing (AM) of a novel class of fine-grained, corrosion resistant, and high strength alloys based on chromium is enabled by a new approach to accelerated sintering in the solid state. This paper will briefly describe both the novel 'nano-phase separation sintering' mechanism that occurs in this class of materials, and the development of a suitable AM processing to make complex 3D shapes. By printing green bodies using the bound metal deposition (BMD) method and taking advantage of the new alloy's rapid sintering characteristics, we produce alloy components that offer an alternative to stainless steels with a combination of lower weight, higher stiffness, excellent corrosion resistance, high strength, and high hardness without requiring any heat treatment. This technology offers an example where an AM process not only provides a shape advantage, but a processing and material property advantage as well.

Introduction

Additive Manufacturing (AM), also widely known as 3D Printing, holds the promise of being able to fabricate shapes without limitation and without the need for any tooling. Though early work on AM technology started in the late 1900s (earlier known as Additive Freeform Fabrication [1]), it has recently gained popularity as a manufacturing method that does not rely on subtractive technology (machining) nor on the use of tooling. The shaping flexibility and the ability to make lightweight structures through the use of infills opens up myriad new applications. Companies in this area have received substantial investment in recent times (especially in the last 10 years) with several start-up companies recently attaining "Unicorn" status (private companies with a valuation of over $1 Billion) [2]. A comprehensive report about the current status of the AM Technology is published yearly by Wohlers Associates [3].

Though there are a variety of competing AM methodologies, they share some common features. The 3D printing process fabricates complex near-net shaped 3D parts by importing 3D computer-aided design (CAD) data files digitally and virtually slicing them into thin layers [3]. The parts are then built up layer by layer to create the complex 3D geometry. From initial success with polymer-based 3D parts, such