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MECHANICAL PROPERTIES OF 3D PRINTED METALS

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ABSTRACT

With the advent of 3D printing technology growing fast, it is important to determine the properties of objects made by this new process. Since some sensitive products, used in life-sustaining applications, are currently made by 3D printing, the reliability and durability of such components must be closely examined. Mechanical properties of metals may vary with the direction of heat transfer during solidification. This study presents the results of tensile tests, conducted at microscale on samples extracted from 3D printed metals. The implications of the variation of strength with solidification direction on the reliability of such metallic objects are discussed.

INTRODUCTION

The manufacturing industry has finally embraced 3D printing as a manufacturing process for making custom products geared for desired applications. This is a revival of old practice of individualizing products, which was prevalent before industrial revolution that brought about automation and mass production. While products became more affordable, the desired size or functionality was somewhat compromised by mass production, occasionally leading to one-size fits all situations. This paradigm is now shifting with the additive manufacturing becoming faster and cheaper as a serious contender to mass production processes. At this time, extensive efforts are underway in order to expand the realm of additive manufacturing making it applicable to more sensitive parts and products. Industry in general and General Electric (GE) in particular have taken long strides in making 3D printers capable of making parts from nearly any material. The plan is so solid that universities such as University of Cincinnati have taken steps towards creating degrees in additive manufacturing.

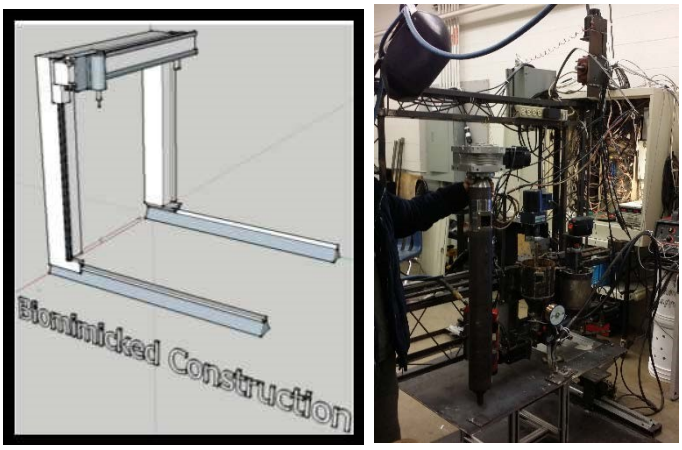

Fig. 1: The schematic of the Gantry-type 3D printer (left) and the image of the actual printer (right).

Additive manufacturing process often involves solidification of softened or molten materials. Based on the type of layering and how the deposition head moves, the mechanical properties of the product may vary with the direction of tool path. Parts made by 3D printing with ceramic or metallic powder may be relatively homogenous, exhibiting similar properties in x, y, and z directions (e.g. length, width and height directions). On the other hand, 3D printing with an arc welder may result in directional properties. This is particularly true for thermal processes