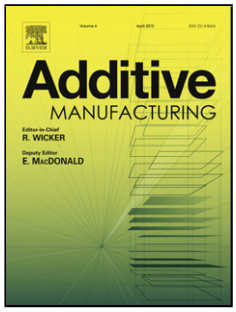

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CHARACTERIZATION OF MAGNETIC PARTICLE ALIGNMENT IN PHOTOSENSITIVE POLYMER RESIN: A PRELIMINARY STUDY FOR ADDITIVE MANUFACTURING PROCESSES

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ABSTRACT

Material jetting 3D printing is an additive manufacturing technique that allows producing complex parts without tooling and minimum material wastage. In this study, orientation control of randomly shaped, anisotropic hard magnetic ferrite particles is demonstrated for material jetting-based additive manufacturing processes using a developed particle alignment configuration. Strontium ferrite and PR-48 photosensitive resin were used as the base materials. An automated experimental setup with two neodymium permanent cube magnets capable of generating a dipolar magnetic field was built to align magnetic particles in the resin. Particle alignment was characterized for directionality using images obtained through real time optical microscopy. The orientation of magnetic particles was observed to be dependent on the distance of separation between the cube magnets and the magnetization time. X-ray diffraction was used to indicate the c-axis alignment of the hexagonal strontium ferrite particles in the cured specimens. The influence of process parameters on particle orientation was evaluated, employing a full factorial experiment analysis. This fundamental research serves as a basis for constructing and optimizing the magnetic particle alignment setup for additive manufacturing processes.

Keywords: Material jetting, Magnetic particles, Finite element method magnetics, Particle alignment characterization, Directionality analysis

1. INTRODUCTION

Material jetting is an Additive Manufacturing (AM) technique used to create three-dimensional (3D) solid parts by dispensing material from a print head on a substrate. Highly researched areas and most promising materials for future applications include the printing of polymers, ceramics and metals [1]. Material jetting 3D printing, which is analogous to inkjet printing, is a well-established process utilized to create solid parts by depositing liquid photopolymers using a print head and subsequent curing using ultraviolet (UV) light. Examples of associated printing equipment include the MultiJet (3D Systems, Rock Hill, South Carolina, United States) and PolyJet devices (Stratasys, Eden Prairie, Minnesota, United States), which are capable of depositing materials selectively and subsequent curing to fabricate multi-material parts [2]. In several publications the use of direct inkjet printing for fabricating components from alumina (Al_2O_3) and lead zirconate titanate (PZT) ceramics was demonstrated [3], [4]. Metallic particles suspended in a polymer resin have been used to print components for electrical applications. For example, nano-particulate inks containing gold and copper have been printed successfully utilizing an inkjet printing process [5]. Huang et al. printed gold nanocrystals using