3D PRINTING OF BIOMIMETICALLY INSPIRED ZIRCON FOR CERAMIC MOLD COMPONENTS

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1. Abstract

The aim of this work is to develop a methodology to 3D print ceramics of Zircon for printing thin walled, biomimetically inspired structures with high aspect ratio. Zircon ceramic is a type of ultra-high temperature ceramic with high natural toughness and hence is an ideal choice for the desired application. Zirconium Silicate powder along with a binder and water was used in order to prepare the slurry for printing. An extrusion-based 3D printer was assembled and configured to print using the Zircon slurry. A sintering treatment was performed on the printed parts that were in green state. Finally the mechanical and physical properties of the printed parts were obtained to optimize the printing process. The application of this 3D printing technique was also investigated to develop bio mimicking structures.

2. Introduction

Everything comes from nature. Be it the ability to develop machines to fly or dive deep into the oceans. Time and again nature has helped us to solve puzzles by observing the keen details of organisms. The so prolonged problem of reducing drag and wake turbulence in aircrafts was solved using such an observation of birds' wingtips.[1] Similarly, nature provides an excellent inspiration for the design and fabrication of next generation functional materials and structures. [2] Organisms rely upon these structures for functions such as structural support, feeding and defense against predators.[2]

With the advent of technology in the manufacturing sector, 3-D printing has come across to be one of the novel and efficient ways to mass produce parts with intricate details. It gives us the flexibility to deal with a wide range of geometries. [4] Almost any geometry can be 3-D printed by using a digital model data from an Additive Manufacturing File (AFM). Unlike the conventional manufacturing processes wherein material is removed from a large chunk, 3-D printing incorporates the addition of material in a layer by layer fashion. This makes it an attractive tool in rapid prototyping and manufacturing of complex biomimetic structures. [5]

The material used in this study is Zirconium Silicate generally known as Zircon. It is a type of ultra-high temperature ceramic with high natural toughness. [6] Its high thermal resistance makes it an ideal choice for mold manufacturing applications. Zircon also has a fairly high thermal diffusivity compared to silica which gives it greater chilling power and faster freezing of castings. [3] The structure and material specifications of Zirconium silicate can be seen in Figure 1 and Table 1 respectively.