Binder-Jet 3D Direct Metal Printing of Cobalt Chrome Moly Alloy

James W. Sears, Christopher Allen, and Andrew Holliday,

Carpenter Technology Corporation,

Reading, PA 19601

ABSTRACT

The Carpenter Cobalt-Chromium-Molybdenum – Middle Carbon (CCM®-MC) alloy powder is being evaluated as a viable material for component fabrication via Binder-Jet Printing (BJP) additive manufacturing. Results from sintering experiments where obtained at temperatures of 1285 °C, 1300 °C and 1325 °C. Initial sintering response was measured through assessment of final densities. Densities of 80 to 100 percent of theoretical were obtained with some evidence of liquid phase sintering. Binder saturation levels seem to have an effect not only on printing dimensional anisotropy, but also on optimum sintering temperatures and resultant chemistry. The chemistry, microstructures and mechanical properties of BJP CCM-MC are compared to those of laser powder bed fusion (LPBF) additive manufacturing.

INTRODUCTION

Carpenter CCM-MC alloy powder is a non-magnetic, Co-28Cr-6Mo alloy exhibiting high strength, corrosion resistance, and wear resistance. This alloy is a powder metallurgy version of Carpenter CCM and CCM Plus® alloys, and is a high nitrogen, middle carbon version of ASTM F75 cast alloy. Carpenter CCM-MC alloy powder is produced by vacuum induction melting (VIM) followed by nitrogen gas atomization. Carpenter CCM-MC alloy powder has excellent weldability in laser and electron-beam additive manufacturing processes [1].

BJP technology produces components by printing binder to fabricate green shapes that are then sintered, and in some cases, Hot Isostatic Pressed (HIP'd) to achieve final densification. Properly controlled the BJP process can produce material that meet standards developed by the Metal Injection Molding (MIM) industry. There are several reports on BJP of certain alloys including 316L, 420, 17-4PH, 625 and 718 [2-