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Abstract

A study was carried out to evaluate the wear properties of Binder Jet 3D Printed (BJ3DP) WC-12%Co per the ASTM B611 and G65 test methods. The printed samples were sintered under a pressure of 1.83MPa at 1485°C for 5 minutes to achieve near theoretical densities. A dual WC grain size was observed in the microstructure of the sintered parts. The microstructure largely consists of 1.4 – 2.0 µm WC grains and clusters of coarse grains ranging in size up to ~ 20 µm in the Co matrix. The samples showed a volume loss of 140.48±2.73 mm^3 during the B611 testing. The wear resistance of the samples was found to be superior to that of standard cemented carbides with similar amount of Co. The superior wear resistance is attributed to the dual grain size microstructure. The SEM micrographs of the wear surfaces after B611 testing showed the fragmentation and pull out of WC and substantial wear of the Co matrix. The G65 wear testing showed a volume loss of 3.67±0.66 mm^3. The SEM micrographs of the wear surfaces after the G65 testing showed wear occurring primarily in the Co matrix. The results from the present study confirm the feasibility of the BJ3DP process to fabricate WC-12%Co parts with superior wear resistance properties.

Introduction

The WC-Co cermet, popularly known as cemented carbide, is widely used for manufacturing parts for wear applications, due to its ideal combination of high hardness and good toughness. The wear properties of WC-Co play a crucial role in the performance of numerous parts used for applications in mining, molds, drilling, bearings etc. Many studies have been focused on understanding the wear behavior of WC-Co cermets [1-10]. The grain size of WC was identified as a critical parameter affecting the abrasive wear of the WC-Co cermet. A linear relation of increase in wear resistance with decrease in square root of the WC grain size was observed for cemented carbides with varying amount of Co contents [1]. Cemented carbides with smaller WC grain size exhibit higher hardness preventing the penetration of abrasive particles and increasing the overall abrasive wear resistance [4]. Cemented carbides with smaller WC grain size also improve the erosion resistance by lowering the Co free path and strengthening the Co matrix by promoting faster dissolution of WC during the liquid phase sintering process. [4,11-13].

Depending on their geometric complexity, wear parts can be manufactured by pressing in a die and sintering or by cold isostatically pressing a blank, followed by green machining and sintering. The cost of dies is high, and green machining can also be expensive for parts with