Chapter 1
The Effects of Feedstock Powder and Deposition Technique on the Hardness and Tribological Performance of Thermal-Sprayed WC–Co Coatings

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ABSTRACT
The wear resistance of thirty WC-Co coatings, deposited by standard High-Velocity Oxyfuel (HVOF) techniques and a high-temperature variant of HVOF, with standard commercial and experimental nanostructured feedstocks, is examined. It is found that the high-temperature gun produces harder and more wear-resistant coatings than the standard gun. The latter does not generate high enough temperatures to melt the powder and provide good bonding between WC grains and Co binder. All

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coatings present higher wear resistance than the steel substrate. Coatings deposited with standard feedstock possess generally higher wear resistance than nanostructured coatings. The difference is more pronounced in sliding than in abrasive wear. WC-Co Coatings deposited with nanostructured feedstocks are recommended for use in bearings and other machinery with sliding parts because they inflict much less wear on the material on which they slide than conventional coatings. Coatings with micrometer WC grains are recommended for abrasion resistance applications such as earth moving or slurry processing machinery.

INTRODUCTION

At the turn of the century, the Office of Naval Research funded a concerted program to investigate the potential of nanostructured coatings for applications in bearings and in abrasive media. The purpose of the research was to find whether coatings made of feedstock with nanometer-sized WC grains possess advantages over the commercially available coatings. It is easy to imagine the potential savings in labor, material and especially down time offered by the possibility of repairing, say, the worn surface of the bearing on a ship’s large propeller shaft by depositing material in situ, rather than disassembling, fabricating and installing a new shaft. The research program involved a number of commercial providers of precursor material, companies specializing in various deposition techniques, and universities doing research in material synthesis and in the various deposition technologies; performing structural characterization of the coatings, and evaluating their performance. Our laboratory was charged with measuring the coating’s resistance to sliding and abrasive wear and relating this performance to the nature of the feedstock and the deposition technique. The present contribution combines the observations described in previous reports (Qiao, Liu & Fischer, 2002, 2003) and provides a new analysis.

The processing of nanoscale WC had started when Larry McCandlish was investigating the potential of WC as a catalyst at Exxon Research Laboratories. Catalysts are prepared as nanometer grains that are dispersed on a support from the aqueous solution of a salt. His colleague Richard Polizzotti enquired about the possibility of co-dispersing cobalt with the same method. This led to the development of the Spray Conversion Processing of nanometer scale WC/Co composites at Nanodyne, a company founded by Bernard Kear for that purpose (McCandlish, Kear & Kim, 1992). It was known that WC/Co composites with nanometer size WC grains are harder and possess a higher resistance to sliding and abrasive wear than conventional cermets (Jia & Fischer, 1996, 1997, 1998). Since the structure and mechanical properties of coatings sprayed onto a substrate are different from those of bulk materials, the possible advantages of nanostructure in coatings needed to be verified.
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