QUANTITATIVE PHASE ANALYSIS OF HVOF WC COATINGS USING RIETVELD MODELLING OF X-RAY DIFFRACTION PATTERNS

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High Velocity Oxy-Fuel (HVOF) sprayed tungsten carbide coatings are strong candidates for replacement of electroplated chrome in aircraft landing gear and other applications. Tungsten carbide coatings are required to provide protection against sliding, abrasive, erosive and fretting wear. HVOF coating performance is strongly dependent on its microstructure. Mechanical properties of the coatings is a complex function of carbide size, shape, distribution, matrix hardness and toughness, and the presence of various reaction products which arise due to the very high temperature with which the coating is being sprayed. In general, optimum wear performance is achieved with HVOF coatings which retain a large fraction of small, uniformly-distributed grains of tungsten carbide (WC) with as little as possible of the derivative phases - alpha-W_2C, ternary Co-W-C phases, and a possible amorphous phase.

Due to the unique nature of the HVOF coated metal coupons, quantitative phase analysis using conventional internal standard methods was not possible. In the past, x-ray diffraction patterns were analyzed by taking peak-height ratios for each crystalline phase involved, which, of course, would not account for the presence of amorphous material. Here, a Rietveld Refinement Method is used to determine the amount of each of the crystalline phases and the non-crystalline phase in the HVOF coatings using X-ray diffraction patterns obtained directly from the HVOF coated coupons. Initially, one HVOF coating was ground off, carefully collecting the removed coating particles, an internal standard added, x-ray diffraction carried out, and results analyzed by Rietveld refinement showing that the ($W_{20}Co_6C_7$) crystal structure would be representative of the amorphous component in the HVOF coatings and usable for quantifying the amount of amorphous material present in the HVOF coating.

Rietveld refinement results of x-ray diffraction patterns, obtained directly from the HVOF coated coupons, show that the coatings have varying amounts of amorphous material ranging from 35% to 93%. Correlation studies between the percent amorphous material and wear test results indicate that HVOF coatings with high amorphous phase amounts do not perform as well in wear tests. It is concluded that the amount of amorphous phase in the HVOF coatings directly affects the wear characteristics of the HVOF coatings.