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Corrosion of tungsten carbide exposed to organic acid environments

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Abstract

Corrosion plays a major role in decreasing a tool's lifespan during abrasive applications. The main focus of this study was to investigate the effect of the binder compositions on the wear, corrosion and tribocorrosion resistance of the WC-Co by varying the binder contents. The study involved a characterization of microstructures, grain size, hardness, and chemical composition by using energy X-ray dispersion in the SEM. The corrosion and tribo-corrosion behaviour of the WC-Co was investigated using an electrochemical and cyclic potentiodynamic polarization test in 3.5% NaCl at pH 2, 3 and 5 of acetic and sulphuric acid solutions, respectively. Electrochemical corrosion resistance was determined by performing the OCP for 1 hour followed by a potentiodynamic scan at a scan rate of 0.17 V/s for the samples exposed to both acidic salt solutions. Furthermore, the tribo-corrosion characteristics were investigated by assessing the electrochemistry while samples were exposed to a ball-on-disc test.

The density of the WC-Co alloys was between 13.93 to 14.45 g/cm3 with microhardness values ranging from 1400 to 1730. The alloys had shown a fine microstructure, 6.4%Co-3.2%Ni-2.0%Cr-4.8%V had more fine-grained structure with high $HV_{0.3}$ value of 1730. During the cyclic polarization test, the additions of chromium and nickel had shown to have an effect in stabilizing the cobalt binder phase at pH 2 and 5. The grain size had little influence on the corrosion behaviour of the alloys. Positive hysteresis loop was observed at higher pH levels, where it was dictated that the presence of chloride ions in acid might accelerate the growth of pits during the cyclic potentiodynamic polarization test. Negative hysteresis loop was also observed at lower pH levels for an alloy with <1%Co as the reverse scan had shown a decreasing current density. During the tribocorrosion test, it was found that the wear conditions, alloy, and acid electrolyte controlled the wear-corrosion interaction. While some alloys had shown dominant corrosion behaviour, the hardmetals did not show any wear. The varied pH conditions had a great influence on the wear rates of the alloys which in turn accelerated the corrosion attack with increasing acid strength.