ABSTRACT

The aim of this work was to establish the effect of Ru additions on the properties of WC-VC-Co alloys. Since previous studies had shown the beneficial effects of having either VC or Ru added to WC-Co alloys, having both VC and Ru in the same alloy system was worth investigating. The following aspects were investigated: magnetic properties, microstructural characteristics, hardness, sliding wear and corrosion properties. Four alloy series: 80WC-10VC-(10-*x*)Co-*x*Ru ($0 \leq x \leq 3$), (89.6-*x*)WC-0.4VC-10Co-*x*Ru ($0 \leq x \leq 2$), (89.2-*x*)WC-0.8VC-10Co-*x*Ru ($0 \leq x \leq 2$) and 89.6WC-0.4VC-(10-*x*)Co-*x*Ru ($0 \leq x \leq 3$) (wt%) alloys were investigated. These compositions allowed establishing the effect of varying Ru at low and high VC contents, and also the effect of Ru partially substituting the Co binder or the WC hard phase. The composition of all alloys in this work is expressed as (wt%) unless stated otherwise.

Magnetic saturation decreased with Ru additions, but did not respond to changes in VC content. Coercivity decreased with Ru additions but was higher for alloys with higher VC content. Generally, the WC mean intercept length decreased with Ru additions and VC content. The binder mean free path generally decreased with Ru and VC contents. Substituting Co with Ru increased the contiguity but the opposite was observed when Ru replaced WC. Higher VC contents corresponded to lower contiguities**.** Ruthenium additions and higher VC contents increased hardness, but decreased fracture toughness. The wear rate decreased with Ru additions and higher VC contents. There was a general improvement in corrosion resistance with Ru additions in all three corrosion environments. The effect of VC content on the corrosion behaviors of the alloys in all corrosion environments was not clear. The alloys corroded most in 1 M H_2SO_4 and were more stable in both 1 M NaCl and synthetic mine water.

Due to the complexity of the alloys, some relationships in literature were not always seen, for example those for WC-Co alloys. Overall, the 80WC-10VC-8.0Co-2.0Ru (wt%) alloy was the optimum, based on performance and Ru content.