ABSTRACT

This study investigated the C-Ni-V ternary phase diagram and identification of possible abrasive-resistance alloys. Twenty-four alloys were made from the elemental components and were arc-melted under an argon atmosphere, using Ti as an oxygen-getter. These alloys were analysed in both the as-cast condition, and after annealing for 1000^{o}C and water quenching. Microstructural characterization was carried out in a SEM with EDX, and was done to confirm the phases. The results were used to plot a solidification projection and all binary phases extended into ternary, except for ~Ni_8V, ~NiV_3 and ~V_2C which were not found, due to the sample compositions chosen. The extensions of the binary phases were: ~Ni_3V: ~15 at.% C; ~Ni_2V: ~20 at.% C; σ′: ~18 at.% C; (Ni): ~27 at.% C; ~V_8C_7: ~2 at.% Ni; ~V_6C_5: ~2 at.% Ni and ~VC: ~2 at.% Ni. The liquidus surface was derived, and three ternary invariant reactions were identified. The isothermal section at 1000^{o}C was also constructed.

Hardness of the alloys was studied in both conditions. Alloys with (Ni) (188-402HV_5) were found to be ductile with low hardness. Alloys containing (V), ~Ni_3V and ~Ni_2V were identified as hard phases (533-1052 HV_5). Alloys with σ′ phase were very hard (1065-1266 HV_5) extremely brittle with cracks. Fracture toughness of the C-Ni-V alloys 0.9-5.2 (MPa.m$^{-1/2}$) were comparable with ceramics 0.5-5.3(MPa.m$^{-1/2}$).

The wear behaviour of the alloys was characterized by sliding the carbide alloys against a Cr-steel ball in a pin-on-disc configuration. There were several co-existing wear mechanisms: abrasion, adhesion and the formation of a thin tribolayers. The wear coefficients for a 10N contact load after a sliding wear path of 300m varied between 0.1 x 10^{-6} and 7.6 x 10^{-6} (mm^3/Nm), which was not as good as WC-Co hard metals, but close.