ABSTRACT

This work was done to select a possible replacement for cobalt as a binder through a phase diagram approach using selected WC-X systems. The study was in two parts; experimental and calculations using Thermo-Calc. Potential binders were identified by searching for solid solution formation, a similar melting point to cobalt, and a small solubility for WC as main requirements, from phase diagrams. The experimental samples were designed to be 50 at.% WC and 50 at.% binder for easy manufacturing and analysis, even though this is not an optimum amount for application. Twelve different alloy compositions were prepared and were analysed in both as-cast and heat treated conditions. The samples were annealed at 1000ºC for 168 hours under vacuum. Microstructure characterization was carried out on two scanning electron microscopes with EDX, and X-ray diffraction was done. Two sets of calculations were made, with one comprising the same composition studied experimentally (50 at.% WC and 50 at.% binder), and a more realistic composition comprising 90 at.% WC and 10 at.% binder. The latter was done to give a better understanding to the experimental microstructures.

Most of the WC decomposed into W_2C; this was attributed to the high temperature of the arc-melter and should not occur on normal hard metal preparation. Most of the compositions calculated had solid solution binders and WC. Thermo-Calc could not predict the decomposition of the carbide phase at high temperature. Some phases identified were similar in both the experiments and calculations. Sample W_{25}:C_{25}:Ni_{43}:V_7 had the binder phase initially solidifying as (Ni) but transformed into ~Ni_2V on cooling; it was identified as the most likely alloy to replace cobalt but will still need further work such as preparing a more realistic composition, manufacturing by sintering, and comparing properties such as hardness with WC-Co. Thus, the binder composition was selected from the Ni-V binary system.