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Processing, characterization and tribological assessment of novel WC-VC-Co coatings and alloys

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ABSTRACT

This thesis describes a number of novel WC-Co sintered alloys (conventional and spark plasma) and thermal spray coatings, with the addition of 10wt%VC. The VC addition was kept constant for all materials while the Co binder content was varied for the thermal spray coatings (12wt% and 17wt%). The production route of the hardmetal is by powder metallurgy techniques. All the production processes were closely monitored and optimized. The properties of all the materials produced were evaluated using standard hardmetal quality control procedures. The wear performance of the materials was characterized in terms of friction response, sliding wear resistance and slurry erosion resistance.

In general, the addition of 10wt%VC to WC-Co produced a material with a better hardness, comparable toughness and a less dense material for weight saving applications, thus making VC a good substitute for WC. The VC led to WC grain refinement in both coatings and sintered materials. None of the starting VC from the powders remained in the produced materials, as the VC formed the WV_4C_5 phase. The presence of the WV_4C_5 phase resulted in a higher hardness. Despite a poorer wettability of the VC by Co compared to WC, the porosity in the WC-Co-VC materials was minimal. The XRD spectra of the WC-Co-VC materials did not show any eta phase. The wear performance of the materials was generally improved with the addition of the VC with minor exceptions. The wear mechanisms in the sliding wear and slurry erosion wear systems were found to be similar for all three material types. The mechanisms included preferential binder removal, adhesion, smearing, carbide grain cracking, grain pull-out, and formation of thin tribo-films.