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**Effect of VC, Cr₃C₂ and Ru Additives on Mechanical Properties
of WC-10wt%Co Sintered with Spark Plasma Sintering**

MSc Dissertation

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Abstract

This dissertation presents the effect of VC, Cr₃C₂ and Ru additives on the mechanical properties of WC-10wt% Co manufactured using spark plasma sintering (SPS). Spark plasma sintering has the advantage of being a high-speed sintering process and achieves full densification (>99%) at a lower sintering temperature than other conventional sintering techniques, thereby preventing Ostwald ripening. The study involved the characterisation of the microstructures of both powder and sintered samples morphology and phases present using optical microscopy, particle size analyser, SEM and XRD. Eight samples were made with a composition of 0.2wt% of the grain growth inhibitors (VC, Cr₃C₂ and Ru) and base sample of WC-10wt% Co. The powders were milled using a planetary ball mill with 4:1 ball- to-powder ratio. Powders were sintered in SPS at 1150°C for 8 minutes at 50MPa under vacuum and the relative density of all samples was above 99%. The addition of grain growth inhibitors successfully decreased the WC grain size from a maximum of $0.524 \pm 0.003 \mu\text{m}$ to a minimum of $0.489 \pm 0.002 \mu\text{m}$. The binder mean free path and WC contiguity was dependent on the amount of WC/WC contact, and smaller WC grain size resulted increased Co binder between WC, thus lowering the number of WC/WC contacts. Therefore, decreasing the binder mean free path increased the hardness of the samples. Since there was an inverse relationship between binder mean free path and WC contiguity, a lower WC contiguity resulted in a lower hardness and an increase in fracture toughness.