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The impact of impurities on sintering behaviour and mechanical properties of cemented carbide

This research was conducted as a Master's thesis for University of Luxembourg at CERATIZIT Group, Luxembourg. Within the course of this research, the impact of impurities on the mechanical properties of cemented carbides together with their sintering behaviour are studied. The material studied here consists of submicron-sized grains as the hard phase with 10.3wt% of metallic binder. The reference sample used for sake of comparing the results also includes some grain growth inhibitors.
Tests conducted on samples included the mechanical tests (transverse rupture strength, hardness and toughness), magnetic tests (magnetic saturation and coercivity), for which the samples are sintered under the same sintering program. Other series of tests included thermo-analytical tests; dilatometry test was performed on green cylindrical pieces with circular bases, but the thermogravimetry test was performed on mixed powders that were pressed manually.
The tests were evaluated through microstructural analysis, providing a visual understanding of the influence exerted by various additives on the samples'microstructure. Mixing additives with the reference sample was carried out during ball milling and included two types: transition metal cubic carbides and additives of metallic binder type. Except for Mo2C and Cr3C2 with two levels of addition, all the other additives were in three levels of content.
In all cases of Grain Growth Inhibitor (GGI) addition, the hardness increased, the toughness decreased, and the TRS values showed an initial increase followed by a sharp decline, which could be attributed to surpassing the solubility limits of these additives in the binder phase.
With all mechanical tests results considered, TiC was the most impactful GGI in terms of enhancing the hardness through reducing average WC grain size, diminishing the toughness and TRS through introducing defects and porosity, yet homogenising the microstructure which was reflected through Weibull analysis in TRS testing.

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