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Mechanical Properties of Nanometric Powders of Sintered WC with 10% pCo

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Abstract – This work shows the development of a hardmetal with large properties due to of the use of WC nanometric powder and inhibitors of grain growth (0.6%pVC, 0.6%pCr_2C_3) in consolidation by high pressure and high temperature (HPHT) and conventional sintering. HPHT conditions were P = 5GPa, T = 1300-1400-1500 º C, t = 2-4 minutes (Sample 1: Convencional/1400° C/45 min - Sample 2: 5 GPa/1300º C/2 min - Sample 3: 5 GPa/1300º C/4 min - Sample 4: 5 GPa/1400° C/2 min - Sample 5: 5 GPa/1400º C/4 min - Sample 6: 5 GPa/1500° C/2 min - Sample 7: 5 GPa/1500º C/4 min). For comparative purposes, samples were conventionally sintered at T = 1400 ° C, t = 45 min, vacuum of 10^{-2} mbar. These samples were characterized in terms of densification (Figure 1) and mechanical properties (Figure 2) - Vickers hardness (HV30) and the fracture toughness (K_{IC}). Results indicate that the samples sintered 5GPa/1500º C/2min provided best results in terms of mechanical properties when compared to samples of conventionally sintered hard metal, which is not directly correlated to the formation of phase *η* in the samples sintered by high pressure in short time.

The carbide nano-sized provided increased hardness, due to the decrease in grain size of WC and maintaining good toughness [1]. Due to the strong influence of grain size on sintering and densification, it is necessary to use additives of inhibitors of grain growth, such as VC, Cr_3C_2 [2], which provide a more homogeneous microstructure and strength to the hard metal. The carbide additives are soluble in the binder phase (Co) and may segregate at the interfaces of WC/Co forming new crystals or phases that reduce the energy of interface, thus reducing the driving force of grain growth [3]. It was observed that the sample 6 showed densification over 99% with standard deviation insignificant. Sample 3 showed the lowest value of density, showing that temperature significantly influences the consolidation of this material. Increasing the temperature has been increasing the percentage of densification of hard metal, as well as increasing the fluidity Co - eutectic, which by wetting, spreading and formation of clusters close the porosities of the material faster and provides a tougher structure [4]. The denses samples have the highest values of hardness, it had increased in areas of contact interparticles and better packing was achieved, which were provided by the nano-sized grains WC. Another factor is that the HPHT sintering time inhibits the formation of undesirable phases such as η (M_6C and M_3C) - Co_6W_6C and Co_3W_3C [5]. In dopped samples have a more intense decline in the values of the fracture toughness, possibly due to microstructural defects (pores and / or cracks) in the samples, which act as stress-concentration factors, decreasing the toughness of the material [4] - Figure 3. It is known for conventional materials, that the fracture toughness generally decreases as the hardness increases, but for the nanostructured materials high fracture toughness is achieved for a given level of hardness [6]. Generally, the sample 7 offers the best combination of Vickers hardness with fracture toughness.

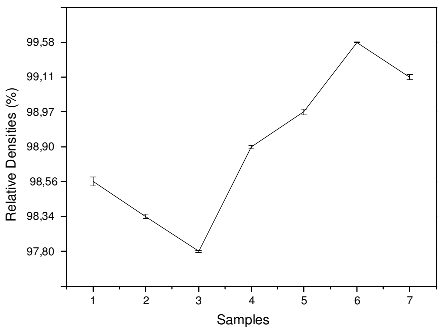

Figure 1 - Densification of the sintered samples

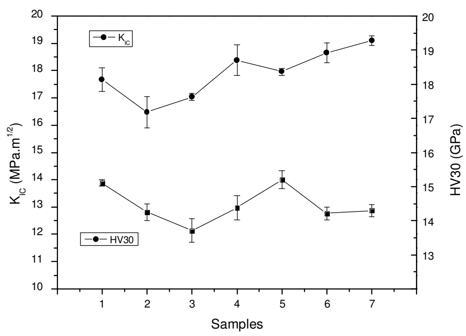

Figure 2 - Hardness and fracture toughness of the sintered samples

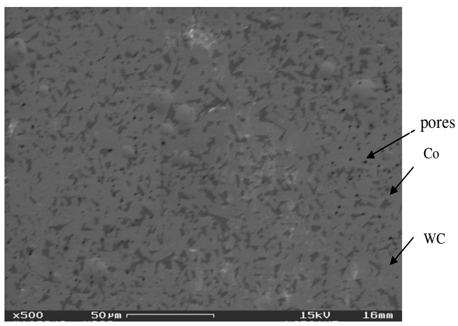

Figure 3 - Micrography of the sample (5GPa/1400 º C/2min)

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