Abstract

Cemented carbides are attractive materials for many industrial applications due to a combination of beneficial mechanical and physical properties, chemical stability and excellent wear resistance. The ultrafine and nanocrystalline cemented carbides are receiving special attention recently due to their application in the development of materials for the electronics and automotive industry. The wear resistance of these materials is increased substantially by reducing the grain size. The reduction in grain size can be obtained by the addition of small quantities of grain growth inhibitors (in particular Cr_3C_2 and / or VC), the selection process and the sintering conditions.

This thesis evaluates the friction and wear behavior during dry sliding for cemented carbides obtained from ultrafine and nanocrystalline WC-12wt.Co with the addition of VC and Cr_3C_2 as grain growth inhibitors. These mixtures were fabricated by both conventional sintering in vacuum and spark plasma sintering. The dry sliding wear tests were carried out with a ball on disk configuration in a tribometer using WC-6Co and AISI 5210 balls as counter materials. The tests conditions were the following: 40N and 60N as contact loads, 2000m and 10000m as sliding distance, sliding velocity of 0.1 m/s, and controlled environmental conditions.

The results have shown that nanostructured cemented carbides have a greater resistance to dry sliding wear than ultrafine or submicron grades. It has been shown that the addition of grain growth inhibitors to the commercial mixture effectively increased the wear resistance, particularly when the proportions are up to 1%wt. and VC is used as inhibitor. The elastic or plastic nature of the contact asperities are apparent in the differences between the coefficient of friction of ultrafine and nanoscale materials. The spark plasma sintering, SPS, (and sintering conditions) was the sintering method which gave the best tribological properties for severe wear conditions. For the traditional sintering method, in a vacuum, the used parameters were not suitable as inhibitor ratios exceeded 1% by weight.

The study of the wear track micrographs by SEM, FESEM, EDX, revealed the coexistence of several wear mechanisms which contribute to the deterioration of the material. This has been associated with the microstructural and mechanical properties of the cemented carbides, the counter material nature and the processing method. Finally, a good microstructural control of fine cemented carbides has shown to exert more influence on the wear resistance than the increase hardness or decrease in grain size alone.