Tool Life Improvement by Deep Cryogenic Treatment

Abstract

Deep-Cryogenic Treatment (DCT) has been introduced in the last decades for the microstructure refinement together with the fully transformation of the Retained Austenite (RA) into martensite and/or secondary carbides which are the key performance of high-speed steels. Investigating these microstructural developments resulting in longer tool-life is the main objective of this research. The micro Vickers with 1000 gf was employed for hardness test while the surface toughness was evaluated using a scratch test. The tribology test was employed using the pin-on-disk technique in order to evaluate wear resistance. X-Ray Diffraction (XRD) was mainly used for phase analysis and characterization. The result showed that the wear resistance of high-speed steel can be improved up to 70% after the DCT while the hardness increases just only 10%. The surface toughness strongly depends on the amount of carbide precipitated in the samples. The XRD pattern showed that the martensite matrix shrinks during the DCT causing the ejection of carbon atom out from the matrix. This phenomenon results in an increasing amount of secondary carbide precipitated in the martensite matrix promoting both the hardness and toughness. Nevertheless, this shrinkage of the martensite matrix can also produce the internal crack in the microstructure due to over aging by the DCT. This lack of understanding in the effect of microstructural parameters on the mechanical properties that will be fulfilled in this research.