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Optimizing the surface integrity of machined Ti-6A-4V using advanced carbide inserts and minimum quantity lubrication

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ABSTRACT

This research is focused on optimizing the surface integrity of Ti-6Al-4V using advanced carbide inserts and minimum quantity lubrication (MQL). Experiments were designed to machine twenty Ti-6Al-4V blocks under dry and MQL lubricating conditions using innovative cemented carbide inserts produced by Liquid Phase Sintering (LPS) and Spark Plasma Sintering (SPS). The cutting speed, feed rate, and depth of cut, were considered as machining parameters, while the cutting force, temperature, tool wear, surface roughness and residual stress were considered as performance characteristics. The results obtained for surface roughness and residual stress measurements were used to analyze the surface integrity of the machined Ti-6Al-4V samples. The influence of sintering techniques and milling parameters on performance characteristics and surface integrity were investigated from experimental results obtained. Discrepancy in behavioral trends with respect to lubricating conditions was also investigated. The analyses of milling results showed that cutting speed played a major role in the optimization of surface integrity of the Ti-6Al-4V workpieces followed by the depth of cut. The results also showed that the LPS inserts performed better than the SPS inserts due to their better mechanical properties (higher fracture toughness (K_{IC}) and transverse rupture strength). The application of MQL was also observed to significantly reduce milling temperatures resulting in better surface integrity. However, an optimized surface integrity of the Ti-6Al-4V samples was achieved during MQL milling with the 10Co-L insert at a low finishing speed of 75m/minute and a reduced depth of cut of 0.5mm.