Title: Surface integrity characterization in high-speed dry end milling of Ti-6Al-4V titanium alloy

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Abstract: Surface integrity is a key property in the functional performance of machined parts and assembled engineering components. In this study, the effects of cutting conditions and tool wear on the surface integrity of Ti-6Al-4V titanium alloy after high-speed dry end milling were investigated. Different cutting speeds (100–300 m/min) and feeds (0.03 and 0.06 mm/tooth) as well as TiAlN + TiN physical vapor deposition (PVD)-coated carbide tool were employed during the machining trials. Surface roughness value and sub-surface microhardness of the machined surfaces were measured, and the corresponding alterations beneath the surface were characterized through electron microscopy. Results showed that surface roughness values at different cutting speeds directly depends on the tool conditions. The use of a new tool contributed to a higher surface quality of 185 nm compared to 320 nm for the used tool at the highest investigated cutting speed. It was found that operating the end milling with the new tool at a higher feed rate significantly decreased the surface roughness of the machined surface from 415 to 225 nm at a lower cutting speed. Feed marks and material redeposition defects were detected on the surface, while plastic deformation was observed in the sub-surface of the machined surface. Microhardness measurement revealed that no significant alterations occurred at the sub-surface when lower cutting speed and feed were employed. Higher cutting speed and feed rate enhanced the sub-surface alteration and resulted in considerable plastic deformation. Microscopic observations further highlighted this behavior.