Influence of the Ti/Al Ratio on the Performance of Ti-Al-N Coated Tools in the Machining of Stainless Steel 304

ABSTRACT

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Machining austenitic stainless steel presents significant challenges due to various factors. One key issue is the material's low thermal conductivity, which can lead to thermal overload on the cutting tool. Additionally, these materials tend to adhere to the tool's cutting edge, resulting in adhesive wear and the formation of a built-up edge. To enhance tool performance, ceramic coatings can be applied, as they improve hot hardness and provide thermal and chemical insulation.

This study focused on evaluating the effect of the Ti/Al ratio in titanium, aluminum, and nitrogen-based coatings during the turning process of AISI 304 stainless steel. The coatings investigated were Ti0.56Al0.44N (TiAlN – Futura Nano®) and Ti0.37Al0.63N (AlTiN – Latuma®), both produced by Oerlikon Balzers Revestimentos Metálicos LTDA. Characterization of the coatings through Energy Dispersive X-ray Spectroscopy (EDS) revealed that the atomic ratio of Ti to Al in the Ti0.56Al0.44N coating is 1.27, while for the Ti0.37Al0.63N coating, the ratio is 0.59.

Machining tests were conducted on a CNC lathe equipped for cutting force acquisition, which was monitored over time until the end of the tool's life. To assess tool wear, the surface roughness of the workpiece was measured using a profilometer after each force test, and the tool geometry was analyzed using a scanning electron microscope (SEM). Preliminary results suggest that the tool coated with Ti0.37Al0.63N may exhibit lower cutting forces and a longer tool life

compared to the Ti0.56Al0.44N coating. Additionally, nanoindentation tests indicated that the Ti0.37Al0.63N coating has a higher hardness than the Ti0.56Al0.44N coating, resulting in greater wear resistance.
Keywords: PVD Coatings, Tool Wear, Cutting Forces.