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Effects of laser texturing on tribological properties and wettability of titanium nitride-coated AISI M2 high-speed steel

Abstract

Excessive friction encountered during the sliding of mechanical pairs usually causes detrimental effects on both the component surfaces and their performance. Elevated contact stresses owing to high friction lead to increased wear and shortened service lifetimes. To mitigate this issue, this study explored a solution involving a surface modification of AISI M2 tool steel. The approach included a titanium nitride (TiN) coating and the laser texturing of a rectangular array of micro-dimples on the metal surface. The effect of laser texturing parameters on dimple size was investigated, and the use of 8-W laser power together with 0.1-second irradiation duration was able to fabricate the desired dimple size to enhance the lubrication. The influences of the dimple density on the coating adhesion, wettability, friction, and wear of laser-textured surface were also examined. The coating adhesions of the untextured and textured TiN-coated surfaces were not significantly different. The textured surface exhibited oleophilic behavior, and oil was more likely to spread on the surface with a higher dimple density. Under a load of 50 N, the surfaces with dimple densities of 5 % and 9 % exhibited low friction compared to the untextured surface. Wear was found to be low on the textured surface due to the enhanced lubricating effect and improved load-carrying capacity. Additionally, the empirically derived Archard wear coefficients showed non-linear wear behavior throughout the sliding length. The obtained results evidence that the laser texturing is feasible for improving tribological performance of the low friction-coated high-speed steel surfaces.

Keywords

Archard wear coefficient; Friction; Laser texturing; Micro-dimples; Wettability