ABSTRACT

Coated cutting tools constitute the lion's share of tools used for material removal processes as they offer immense benefit to the machining industry by providing higher tool life, higher productivity as well as assuring better product quality. An ideal coating for cutting tool should possess good adhesion to the substrate, have sufficiently high hot hardness, anti-friction property and should be chemically inert to the work material under prevailing machining environment. WS_2 coating is known to provide ultra low friction and it excels its widely investigated predecessor MoS_2 in terms of providing effective lubrication at higher temperatures. However, like MoS_2, it also suffers from drawbacks like losing lubricating ability under humid atmospheres, low hardness and poor abrasive wear resistance. TiN, on the other hand is a widely known hard coating, which has been serving the machining industry for decades. However, it lacks self-lubricating property. The present research work aims at combining the beneficial properties of TiN and WS_2 i.e. hardness and anti-friction respectively, in a single coating to be used for machining. Coatings with different architectures were synthesized using pulsed DC closed field unbalanced magnetron sputtering route. They were evaluated and compared in terms of their composition, structural, mechanical and tribological properties. It emerged that a dual layer coating consisting of top TiN-WS_x composite layer with TiN under layer possessed superior adhesion, sufficiently high hardness and exhibited low friction coefficient and wear rate against WC ball counterpart under dry sliding conditions. Further investigation revealed that WS_x content of the order of 15 wt.% in TiN-WS_x composite provided best wear resistance property. Substrate bias applied during deposition, also strongly influenced the properties of such composite and the best performing coating was the one deposited under –50 V bias. Such dual layer coating also established its supremacy when evaluated through dry turning of medium carbon steel. Lesser cutting forces, particularly at low cutting velocities, were registered for TiN-WS_x/TiN bilayer coating in comparison to uncoated as well as TiN coated tool. The same coating also outperformed TiN in terms of wear resistance by attaining significantly higher tool life.

Keywords: WS_2; TiN; Pulsed DC magnetron sputtering; Structure; Adhesion, Hardness; Tribological properties; Dry turning