ABSTRACT

Coated cutting tools can provide immense benefit to the machining industry by providing longer tool life, higher productivity and improved product quality. Ideally the coating should have good adhesion with the substrate, be chemically inert, have hot hardness and possess excellent anti-friction property.

MoS_2 is considered to be an excellent solid lubricant coating, but its application is restricted to vacuum environment as it degrades under high humidity and possesses rather low hardness. TiN, on the other hand, is one of the most widely used hard coatings for cutting tools. It also shows resistance to oxidation at elevated temperature. Since it is difficult to find any single material having all of these properties, one may follow the route of composite coating.

The aim of the current research is to integrate the properties of TiN and MoS_2 to develop a hard solid lubricant composite coating for cutting tool applications. Coatings with various architectures have been deposited using dual cathode pulsed DC closed-field unbalanced magnetron sputtering (CFUBMS) technique. Then the physical, mechanical and tribological properties of the coated specimens have been evaluated. It has been observed that TiN-MoS_x composite coating with a hard TiN underlayer possessed balanced combination of properties like excellent adhesion, sufficiently high hardness and exhibited low friction and wear against steel and cemented carbide ball counterparts. Moreover, optimal combination of various properties of TiN-MoS_x composite coating was achieved with MoS_x concentration in the range of 11–27 wt% and at a substrate bias voltage of −40 V. Superior properties of TiN-MoS_x were also reflected in dry machining of medium and high carbon steel. During dry drilling of IS 30C8 steel, the TiN- MoS_x composite coated drill with TiN underlayer consistently provided lower thrust force and torque and finally resulted in better surface quality of the drilled holes compared to those obtained for uncoated and other coated drills. During dry turning of IS 80C6 steel, the similar coated WC inserts resulted in minimum cutting force and demonstrated tool life which was 8 times higher than that of uncoated counterpart and more than twice than that of conventional hard TiN coated tool.

Keywords: Pulsed DC magnetron sputtering; TiN-MoS_x composite coating; Structural property; Adhesion; Hardness; Tribology; Dry machining.