Thermal stability, mechanical properties, and tribological performance of TiAlXN coatings: Understanding the effects of alloying additions

ABSTRACT

In tribological applications, the degradation of metallic coatings due to oxidation and thermal softening at high temperatures is an issue of increasing concern. Recently, researchers have focused on the development of durable hard coatings that can perform well under elevated temperatures. The alloying of ternary TiAlN coatings with various elements has received considerable attention due to its ability to improve coating properties at high temperatures by solid solution hardening, grain refinement, formation of new phases, diffusion barriers, and self-lubricious tribo-oxides. This paper reviews the microstructure, thermal stability, oxidation behaviour, and mechanical and tribological properties of resultant quaternary TiAlXN coatings (X = Si, Cr, V, Ta and B). The effects of the deposition parameters, chemical composition, high-temperature annealing, and coating architecture on the coating properties are discussed in depth. The properties of quinary TiAlCrSiN coatings are also reviewed to provide a better understanding of the synergistic effects of Si and Cr additions to TiAlN. The maximum hardness and plastic deformation resistance (H/E and $H^3/E2^)$ of TiAlXN coatings produced by various deposition techniques are compared. This paper provides useful insights into the challenges and future research perspectives of the reviewed coatings.