Formation of high entropy film for cutting tool by magnetron sputtering

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ABSTRACT

Hard coating application is effective way of cutting tool for hard-to-machine materials such as Inconel, Ti and composite materials focused on high-tech industries which are widely employed in aerospace, automobile and the medical device industry also Information Technology. In cutting tool for hard-to-machine materials, high hardness is one of necessary condition along with high temperature stability and wear resistance. In recent years, high-entropy alloys (HEAs) which consist of five or more principal elements having an equi-atomic percentage were reported by Yeh. The main features of novel HEAs reveal thermodynamically stable, high strength, corrosion resistance and wear resistance by four characteristic features called high entropy, sluggish diffusion, several-lattice distortion and cocktail effect. It can be possible to significantly extend the field of application such as cutting tool for difficult-to-machine materials in extreme conditions. Base on this understanding, surface coatings using HEAs more recently have been developed with considerable interest due to their useful properties such as high hardness and phase transformation stability of high temperature.

In present study, the nanocomposite coating layers with high hardness on WC substrate are investigated using high entropy alloy target made a powder metallurgy. Among the many surface coating methods, reactive magnetron sputtering is considered to be a proper process because of homogeneity of microstructure, improvement of productivity and simplicity of independent control for several critical deposition parameters. The N2 is applied to reactive gas to make nitride system with transition metals which is much harder than only alloy systems. The acceleration voltage from 100W to 300W is controlled by direct current power with various deposition times. The coating layers are systemically investigated by structural identification (XRD), evaluation of microstructure (FE-SEM, TEM) and mechanical properties (Nano-indenter).

KEYWORDS

High-entropy alloy, Nitride film, Magnetron sputtering, Microstructure