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Role of Amorphous Si_3N_4 on the Microhardness in Ti-Al-Si-N Nanocomposite Film

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Superhard quarternary Ti-Al-Si-N films were synthesized by a hybrid coating technique of arc ion plating and sputtering methods The relationship between microhardness and microstructural change by percolation phenomenon of amorphous silicon nitride into (Ti, Al)N during deposition process The synthesized Ti-Al-Si-N films were revealed to be composite of (Ti, Al)N crystallites and amorphous Si_3N_4, and the grain size of (Ti, Al)N crystallites was diminished due to the percolation of amorphous silicon nitride with increase of Si content When the Si content increased up to about 9 at%, the film was characterized to nanocomposite, *nc*-(Ti, Al)N/*a*-Si_3N_4, and showed maximum hardness of about 55 GPa This hardness value was significantly increased one compared with the hardness value (~35 GPa) of pure (Ti, Al)N film The hardness increase of (Ti, Al)N film with Si addition would result from the grain boundary hardening both by Hall-Petch relation derived from grain size refinement and by strong cohesive energy of interphase boundaries due to the percolation of amorphous Si_3N_4 into (Ti, Al)N film

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Influence of Substrate Bias Voltage on Deposition Behavior and Microhardness of Ti-Si-N Coating Layers by a Hybrid Coating System of Arc Ion Plating and Sputtering Techniques

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In this work, the influence of substrate bias voltage on deposition behaviors such as deposition rate, macroparticles, and surface roughness were investigated for the Ti-Si-N coating layers deposited on WC-Co substrates by a hybrid coating system of AIP and sputtering techniques And, the microhardness and Youngs modulus with the bias voltage change from zero to −500 V were obtained from nanoindentation technique Applying substrate bias voltage up to −100 V during Ti-Si-N coatings resulted in the significant diminution of macroparticles and smoothening of surface morphology The microhardness and Young's modulus values were also significantly improved, and showed the highest ones of ~60 GPa and ~700 GPa, respectively at bias voltage of −100 V However, the increasing bias voltage above −100 V caused the continual reduction of those properties, and reduced both deposition rate and Si content in the Ti-Si-N coating layer Those phenomena due to bias voltage effect were discussed in this study