Influence of Al-Si-N interlayer on residual stress of CVD diamond coatings

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Influence of Al-Si-N interlayer on residual stress of CVD diamond coatings

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Abstract

Here we report the novel interlayer for the high-quality CVD diamond thin films with reduced residual stress. We used the novel sputtering technique of reactive high power impulse magnetron suttering (r-HiPIMS) which allows us to deposit high quality, void- and defect-free AlSiN interlayer films. The film based on Al-Si-N system shows fully amorphous structure at temperature of diamond film synthesis (800 °C), inertness to diamond and hard WC-Co alloy at elevated temperatures and reduction of the diamond macrostress up to -0.25 GPa for film with AlSiN interlayer. Additionally, varying the Al content in Al-Si-N film we can finely tune its mechanical properties and total stress in substrate – AlSiN – diamond system. We show that AlSiN with the combination of its properties overcomes conventionally used interlayer materials for CVD-diamond such as transition metals or their nitrides and carbides.

Keywords: residual stress, Al-Si-N interlayer, HFCVD diamond film, HIPIMS sputtering.

Introduction

Diamond is the hardest known substance with hardness H > 100 GPa, Young's modulus E > 1000 GPa, extremely high thermal conductivity, chemical inertness, and wear resistance [1–3]. This unique combination of physical properties makes it an ideal candidate material for cutting tool applications [1,3–11]. However, the CVD diamond coated cutting tools often fail in machining because of the poor adhesion between diamond films and WC–Co substrates. The binder phase Co in the substrates can cause graphitisation during the diamond deposition [12,13]. Moreover, due to the high synthesis temperatures (500-800 °C) and strong mismatch in the