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(Microstructure and stress evolution of boron nitride thin fims with varying the substrate bias)

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Boron nitride (BN) is a very attractive material owing to its similarities of lattice structure (hexagonal and cubic forms) and excellent physical properties to diamond such as high hardness, good thermal conductivity and electronic properties. Moreover, it is adequate to next generation cutting tool coating for ferrous metals machining due to its inertness to the ferrous metals. Thus, the synthesis of cubic boron nitride (cBN) from the gas phase has been an attractive issue for a decade. The cBN films have been synthesized using physical and chemical vapor deposition techniques. The assistance of energetic ion bombardment is required for cBN growth regardless of the deposition techniques, the total momentum of the bombarding ions is considered as important parameter. However, clearly none of the simple model gives a completely satisfying mechanism of cBN formation. Recently, the stress-driven model which proposes that the cBN formation is due to the induced compressive stress has been widely discussed. In this study, we investigated the microstructure and stress evolution of BN films with varying the substrate bias which controlled the ion bombarding energy. Films were deposited by unbalanced magnetron sputtering using hBN as target material with argon - 10% nitrogen mixed gas at 1.3 mTorr. The RF power and the target-substrate distance were fixed at 400 W and 100 mm respectively. For a substrate bias, we connected a high frequency (200 kHz) power supply to the substrate. The microstructures of BN films were observed by high resolution transmission electron microscopy. In order to investigate the stress evolution during growth, a system for in-situ stress measurement was sep up. The BN films deposited at low substrate bias had amorphous and turbostratic structures. The amorphous BN films showed that the stress increased with increasing the film thickness and the hardness is up to about 12 GPa. The turbostratic BN films showed the stress relaxation with increasing the film thickness and had very low hardness. Above the critical bias voltage, the cBN phase was synthesized and the stress level of cBN was higher than that of amorphous and turbostratic BN. The relation between the induced stress and the formation of cBN will be discussed.