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Effects of modulation periods and deposition temperation on mechanical properties of HfN/HfB2 multilayers

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Nanoscale HfN/HfB_2 multilayers which have a constant modulation ratio of 1:4 and various modulation periods ranging from 20nm to 60nm and deposition temperature which ranging from 50□ to 200 □ were synthesized on Si (100) substrate by magnetron sputtering. The influence of different modulation periods and deposition temperature on structures, hardness and adhesion of multilayers were studied by SEM, XRD, XP-2 Step Profiler, Nano-indentation. Furthermore, XRD result shows that all the films deposited at room temperature show a crystalline/amorphous mixed structure ,but they have higher hardness and elastic modulus than the HfN and HfB2 monolithic films. The maximum hardness (41.8 GPa)and elastic modulus(505.6GPa) were obtained in the multilayers with the modulation periods of 40nm. This hardest multilayer also show a good crystallinity of HfB_2 (001), (002) andHfN (111) phase at different deposition temperature, the hardness and elastic modulus increases then decreases with the increase of deposition temperature. The maximum hardness and elastic modulus of the HfN/HfB_2 multilayer at 150□ are up to 46.3 GPa and 544.2 GPa.This work proved that magnetron sputtering can produce nanoscale HfN/HfB_2 multilayers with higher hardness and lower compressive stress by controlling different modulation ratios and different deposition temperatures.These mechanical properties strongly depended on the modulation structure and different deposition temperatures.

Keywords
HfN/HfB2 multilayers
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hardness
elastic modulus