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High temperature oxidation of silicon carbide and silicon carbonitride films

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Amorphous SiC a SiC_xN_y films were deposited by reactive DC magnetron sputtering on Al_2O_3(0001) and a-SiC(0001) substrates at room temperature and 600°C. The films with thickness of approx. 2.5μm and nitrogen content ranging between 0-40 at.% (C/Si~1) were sputtered from SiC target at various N_2/Ar gas flow ratios (0-0.48). The as-deposited films were additionally annealed up to 1500°C in Ar and air. Mechanical properties (nanoindentation), chemical composition (SEM-EDS and EPMA), structure (Raman spectroscopy and XRD) and topography (AFM, laser scanning confocal microscopy) of oxidized layers were investigated in dependence on annealing temperature and content of nitrogen.
All SiC_xN_y films preserve their amorphous structure up to 1500 °C, while partial crystallization of a-SiC films starts above ~1000°C. The hardness of all as-deposited and both air and Ar annealed SiC_xN_y films decreases with growth of nitrogen content. The surface of the films is rather smooth without any surface defects bellow 1300°C. Bloom-like patterns are observed on the surface of the SiC_xN_y films after annealing in Ar starting from 1400 °C. These patters cover all the films deposited at RT and only the SiCN film (35 at.% of N) deposited at 600°C. This suggests that both the better structure of the films deposited at higher temperatures and the lower nitrogen content prevent formation of such surface structures, respectively. No bloom-like patterns are present after air annealing at these temperatures. Detailed analyses of hardness and modulus mapping reveal correlation between values of mechanical properties and indentation site. The highest hardness and modulus are observed at the center of the blooms, while the lowest values at the bloom boundary.

Keywords
SiC films
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