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Magnetron sputtered high-temperature Hf-B-Si-X-C-N (X = Y, Ho, Mo, Zr, Ta) films with controlled optical transparency and electrical conductivity

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This work focuses on the effect of Y, Ho, Mo, Zr and Ta addition into hard and thermally stable Hf-B-Si-C-N films in order to improve their optical transparency or electrical conductivity. The combination of the sufficiently high hardness, high thermal stability in air and optical transparency or electrical conductivity opens up a new scope of applications involving high-temperature protection of electronic and optical elements or capacitive pressure and tip clearance sensors for severe oxidation environments.

Hf-B-Si-X-C-N films were deposited onto Si(100), SiC and glass substrates using pulsed magnetron co-sputtering of a single B_4C-Hf□Si-X target in Ar + N_2 gas mixtures. A planar unbalanced magnetron was driven by a pulsed dc power supply operating at a repetition frequency of 10 kHz with a fixed voltage pulse length of 50 μs. The total pressure was 0.5 Pa and the substrate temperature was adjusted to 450°C during the deposition on the substrates at a floating potential.

All Hf-B-Si-X-C-N films possessed a sufficiently high hardness (close to 20 GPa), low compressive stress, high elastic recovery and high oxidation resistance in air at elevated temperatures (above 1000°C). Addition of Y and Ho into the Hf-B-Si-C-N films prepared at the 25% N_2 fraction in the gas mixture resulted in enhancement of the optical transparency. Addition of Mo and Ta into the Hf-B-Si-C-N films prepared at the 15% N_2 fraction in the gas mixture led to an increase in the electrical conductivity.

Keywords

Hf-B-Si-X-C-N films
pulsed magnetron sputtering
electrical conductivity
optical transparency
oxidation resistance