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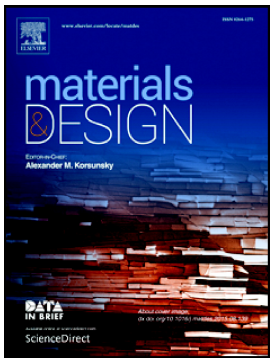

Fracture toughness of Mo2BC thin films: Intrinsic toughness versus system toughening

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Fracture toughness of Mo_2BC thin films: Intrinsic toughness versus system toughening

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Abstract

The fracture behaviour and microstructure evolution of sputtered Mo_2BC films as a function of their deposition temperature is studied. Bipolar pulsed direct current magnetron sputtering was used to deposit Mo_2BC thin films onto Si (100) wafers at substrate temperatures ranging from 380 to 630 °C. Microstructural characterization by transmission electron microscopy revealed that increasing the deposition temperature induces larger and more elongated grains, and a higher degree of crystallinity, transitioning from a partially amorphous to a fully crystalline film. The intrinsic fracture toughness of the Mo_2BC films was studied by focussed ion beam milled micro-cantilever bending tests. A mild dependency of the intrinsic fracture toughness on the substrate deposition temperature was found. Fractograph analysis showed that the fracture behaviour was dominated by intergranular fracture or by fracture within the amorphous regions. Additionally, nanoindentation based fracture toughness measurements were used to probe the fracture behaviour of the Mo_2BC/Si system, where residual stresses define the 'apparent' fracture toughness of the system. Depending on the substrate deposition temperature either compressive or tensile residual stresses developed in the films. This causes a relative change in the system toughness by up to one order of magnitude. The fracture experiments clearly reveal that notched cantilevers provide intrinsic toughness values of a material, while nanoindentation probes the toughness of the entire coating-substrate system. The combination of both techniques provides valuable design information for enhancing fracture resistance of Mo_2BC films.

Keywords: hard coating, fracture toughness, residual stress, nanoindentation, single beam cantilever, transmission electron microscopy.