A framework for modelling the nanomechanical & nanotribological properties of high temperature HfB_xC_y coatings

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ABSTRACT:

High aspect ratio conformal HfB_xC_y coatings were synthesized using low-temperature chemical vapor deposition (CVD). The carbon content was varied in the aggregates, which resulted in thin films with different compositions and mechanical properties. A framework was developed based on mixing of different aggregates to predict the nanomechanical properties of these films. Under this framework, we assumed the growth to be either diffusion or nucleation controlled. Different volume fractions of aggregates were considered. Certain mixing rations agreed well with the instrumented nanoindentation and provided further insights to better understand the results of and nanoscratch experiments. Nanoscratch experiments revealed the coefficient of friction (COF) to diminish to a superlubricity level of 0.05 when the carbon content increases in HfB_xC_y thin films. This value is comparable to DLC, and underlines the immense potential of HfB_xC_y hard thin film coatings for tribological applications. However, due to the shortcomings of C-based coatings such as a-C and DLC, which all experience graphitization and degradation under tribological contact conditions at elevated temperatures above 350 °C, there is a potential need for using ultra-high temperature ceramic coatings such as HfB_xC_y as an alternative for tribological applications.