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Towards nanocomposite and multilayer coatings with high thermal stability and oxidation resistance

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High thermal stability and oxidation resistance are important characteristics for various high-temperature applications. Superhard TiAlSiCN coatings with “comb”-like nanocomposite structure, in which fine (Ti,Al)(C,N) columnar grains were separated by well-developed amorphous SiCN interlayers, recently developed in our group, exhibited the highest thermal stability reported to date for nanocomposite coatings. The main drawback of the above mentioned coatings is, however, a relatively large difference in temperature between the thermal stability (1300°C) and oxidation resistance (1000°C), which limits their use at high temperatures. Various approaches to increase the oxidation resistance of TiAlSiCN coatings are compared: deposition of a thin Al top-layer, Al ion implantation into the surface of TiAlSiCN coatings, and deposition of a thin AlOx top-layer. In addition, multilayer TiAlSiCN/SiBCN and TiAlSiCN/Al_2O_3coatings were fabricated by sputtering of TiAlSiCN, Al_2O_3 and SiBC targets. To evaluate thermal stability, the coatings were vacuum annealed at 1300 and 1400°C. To assess the oxidation resistance, the coatings were heat treated in air at 1000, 1100, and 1200°C for 1 h and their oxidation behavior was studied using SEM and GDOES. The coating oxidation kinetics was also evaluated using simultaneous thermal analysis. The coatings were characterized in terms of their hardness, Young’s modulus and elastic recovery. Deposition of a thin top amorphous AlOx layer was shown to increase the oxidation resistance of the TiAlSiCN coatings from 1000 to 1100°C. Similar high-temperature oxidation resistance was achieved for the TiAlSiCN/SiBCN coatings. In addition, the TiAlSiCN/SiBCN coating with a thickness of individual layer of 80 nm demonstrated even higher thermal stability (1400 ^{o}C) compared with pristine TiAlSiCN coating (1300 ^{o}C).
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