MA5. Boron-containing Coatings:

Superhard single-phase $Ti_{1-x}Al_xB_y$ films with good oxidation resistance grown without external heating using hybrid HiPIMS/DCMS technique

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A hybrid High-Power Impulse Magnetron Sputtering (HiPIMS) and Direct Current Magnetron Sputtering (DCMS) approach with TiB_2 and AlB_2 targets is used to grow $Ti_{1-x}Al_xB_y$ thin films with $0.40 \leq x \leq 0.76$ and $1.81 \leq y \leq 2.03$. The hybrid sputtering method ensures precise control over the energy and momentum of ionized species. The primary aim is to optimize the Al content for enhancing the high-temperature oxidation resistance while maintaining excellent mechanical properties that stem from the diboride structure. No external substrate heating is used resulting in the substrate temperature lower than 180°C.

Oxidation tests performed at temperatures ranging from 700 to 900 °C indicate a substantial improvement in oxidation resistance with higher Al content. Films with $x \leq 0.49$ develop porous, B-depleted oxide layers containing titanium dioxide (TiO_2) phase and often exhibit spallation. In contrast, $Ti_{1-x}Al_xB_y$ thin films with $x \geq 0.58$ form compact oxide scales composed of amorphous alumina (Al_2O_3) and borate ($Al_{18}B_4O_{33}$) phases, which effectively passivate the surface against further oxidation. The oxide scales formed on high-Al content films are much denser and exhibit markedly improved mechanical properties with increased hardness (up to 27.3 GPa, comparable to TiAlN coatings), and also a better adhesion to the underlying substrate material due to better matching of thermal expansion coefficients.

These findings offer a promising foundation for developing high-performance boride-based coatings for applications in the industries such as aerospace and power generation that require coating materials with mechanical strength and resistance to high-temperature oxidation.

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