Ternary transition metal diborides - Next generation protective coating materials?

Helmut Riedl¹, Christoph Fuger¹, Rainer Hahn¹, Tomasz Wojcik², Paul Mayrhofer², Peter Felfer³, Hamid Bolvardi⁴, Peter Polcik⁵

¹CDL-SEC, TU Wien, Wien, Austria ²Institute of Materials Science, TU Wien, Vienna, Austria ³FAU Erlangen, Werkstoffwissenschaften, Erlangen, Germany ⁴Oerlikon Surface Solutions AG, Balzers, Liechtenstein ⁵Plansee Composite Materials GmbH, Lechbruck am See, Germany

helmut.riedl@tuwien.ac.at

Protective coatings for high-performance components – such as blades or powertrain systems in aero engines – constitute an important role for achieving further milestones with respect to carbon emission and environmental sustainability in general. Next to the well-established nitride-based coatings are boron containing systems an upcoming and highly promising class. Here, ternary transition metal diborides are relatively unexplored compared to their binary counterparts such as hard and inelastic TiB₂ or ZrB₂. In the design of novel ternary transition metal diborides diverse challenges arise, whereas the following are major factors: (i) composition-controlled crystallization in PVD based deposition techniques, (ii) limited fracture tolerance and brittle behaviour, as well as (iii) formation of non-adherent and volatile oxide scales. Within this study, we want address these specific challenges on various ternary model systems within group IV to VI transition metal diborides. The phase formation of two competing hexagonal structure types (α-AlB₂ vs ω-W₂B₅₋ₓ), with respect to target composition and ionization degree within the plasma, has been investigated for non-reactive DCMS, HiPIMS, as well as arc evaporation. In addition, different alloying concepts for enhancing the ductile character as well as oxidation resistance of these superhard ternary diborides will be discussed in detail (e.g. W₁₋ₓTaₓB₂ and others). To describe all these relations comprehensively, we correlated the synthesis parameters with structural and morphological evolution using XRD, HR-TEM, APT, as well as micro-mechanical testing methods. Furthermore, specific aspects have also been described by atomistic modelling (DFT).

Keywords
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