INFLUENCE OF TANTALUM ON THE PHASE STABILITY AND MECHANICAL PROPERTIES OF WB_2 THIN FILMS

C. Fuger[a], V. Moraes[a,b], R. Hahn[a], M. Arndt[c], H. Bolvardi[c], P. Polcik[d], P.H. Mayrhofer[a,b], and H. Riedl[a,b]

[a] CDL-AOS at the Institute of Materials Science and Technology, TU Wien, Austria

[b] Institute of Materials Science and Technology, TU Wien, Austria

[c] Oerlikon Balzers, Oerlikon Surface Solutions AG, Liechtenstein

[d] Plansee Composite Materials GmbH, Germany

Future tasks in many different fields of academia and industry are directed towards environmental sustainability, asking also for new advance in the field of protective coatings. Especially, transition metal diboride based films exhibit a great potential to be applied in various applications because of their excellent thermal and chemical stability, high hardness as well as electrical conductivity. Latest studies on diborides showed that this material class prefers to crystallize in two related hexagonal crystal structures: α-AlB2 or ω-W2B5-x prototype, respectively. In a previous ab initio study, we proposed single phased α-W1-xTaxB2 as a material system where the addition of Ta promises to only slightly decrease the excellent mechanical properties (e.g. ductile behavior of α-WB_2) by simultaneously increasing its phase stability.

For an experimental validation of these predictions, we deposited the full compositional range of $W_{1-x}Ta_xB_2$ thin films using magnetron sputtering. On behalf of structural investigations, we could confirm that single phased structured α-$W_{1-x}Ta_xB_2$ thin films are formed up to Ta contents of 26 at.%. These films were investigated by nanoindentation and in-situ micromechanical bending tests to evaluate the mechanical properties. As depicted in Figure 1 $W_{1-x}Ta_xB_2$ thin films outperform well-known systems in terms of fracture tolerance [1].

Based on our results, we can conclude that the experimental investigations are in excellent agreement to the theoretical predictions and the fracture toughness decreases with increasing Ta content only from 3.7 to 3.0 MPa√m.

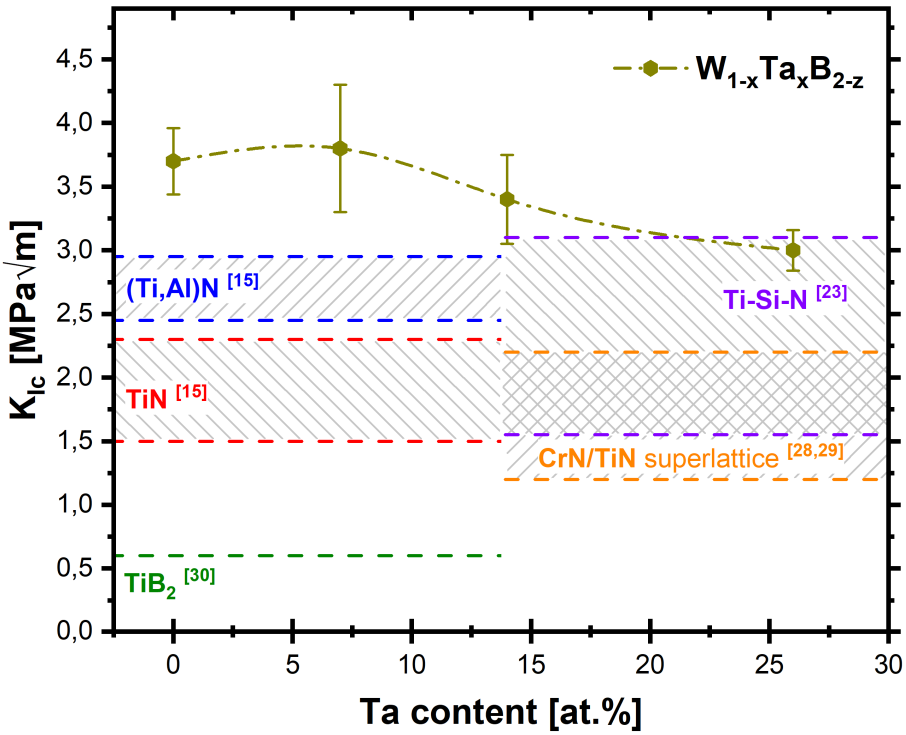

Figure 1: Critical stress intensity factor (K_{IC}) values determined by micromechanical bending tests of microscopic cantilevers, produced from the coatings. The tests were carried out with the following samples: $WB_{1.78}$, $W_{0.93}Ta_{0.07}B_{1.76}$, $W_{0.86}Ta_{0.14}B_{1.83}$ and $W_{0.74}Ta_{0.26}B_{1.87}$. Literature values of (Ti,Al)N, CrN/TiN, Ti-Si-N, TiN and TiB_2 are indicated by the blue, orange, purple, red and green areas and lines, respectively.

REFERENCES

[1] Fuger, Christoph, Vincent Moraes, Rainer Hahn, Hamid Bolvardi, Peter Polcik, Helmut Riedl, and Paul Heinz Mayrhofer. n.d. “Influence of Tantalum on Phase Stability and Mechanical Properties of WB2.” MRS Communications, 1–6. Accessed March 15, 2019.