Toughness estimation of High Entropy Nitride Coatings by tensile testing

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High Entropy Nitrides (HEN) are an interesting material system intended for sophisticated wear and high-temperature applications. Being closely linked to the group of so-called high entropy alloys, which were discovered independently by Cantor and Yeh in the early 2000s [1,2], they consist of five or more nitride-forming constituents in a near equimolar ratio as well as 50 at% nitrogen forming single-phased fcc microstructures. Multiple works have shown that through the use of HEN superior hardness close to or in some cases well into the superhard range (H > 40 GPa) can be achieved while also maintaining high thermal stability [3,4].

For the possible use as protective tool coatings, not only hardness and thermal stability are important factors but also toughness. A method that might be suitable for high throughput screening of coating toughness is tensile testing of coated substrates. The description of critical strains at which first cracks in the coating appear as well as the development of the crack density with increasing applied strain can be used to reasonably estimate coating toughness values.

In this work, three HEN coatings are compared to (AlTi)N via tensile testing. The three coatings are (AlCrTaTiZr)N, (AlCrNbSiTIV)N and (HfNbTaTiVZr)N and were chosen based on previous works of the author [4]. The applicability of that method for the screening of coating toughness is discussed by comparing the results with other more established methods for the estimation of fracture toughness such as micro-beam bending.

It could be shown that tensile testing is a feasible method for high throughput screening of coating toughness.

References

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