MICRO-MECHANICAL TESTING OF TRANSITION METAL (OXY)NITRIDE COATINGS

James S.K.-L. Gibson, RWTH Aachen University
Gibson@imm.rwth-aachen.de
Shahed Rezaei, RWTH Aachen University
Holger Rueß, RWTH Aachen University
Oliver Hunold, RWTH Aachen University
Stephan Wulfinghoff, RWTH Aachen University
Jochen M. Schneider, RWTH Aachen University
Stefanie Reese, RWTH Aachen University
Sandra Korte-Kerzel, RWTH Aachen University

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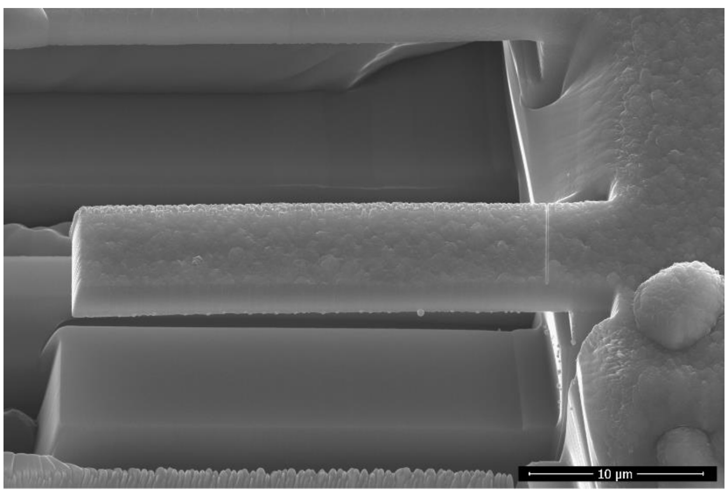
Transition metal (oxy)nitride coatings are used in polymer forming operations for a combination of outstanding wear resistance and chemical compatibility with the polymer materials. Varying the chemical composition and deposition parameters for the coatings will optimise mechanical properties by a combination of chemistry and microstructural optimisation. By developing a representative model for these materials, these materials can be rapidly and efficiently prototyped and improved. However, as both chemistry and microstructure play a role in the material properties, both of these variables must be taken account of in this model. This work demonstrates the first steps in linking quantum-mechanics, micro-mechanics, and meso-scale finite element models together in order to fully understand the behaviour of these coatings.



The effect of thin film composition and temperature on the elastic, plastic and fracture properties of transition metal nitride and oxynitride coatings was invested by nanoindentation, micro-cantilever bending and micro-pillar compression. Vanadium and titanium aluminium nitride and oxynitride coatings were manufactured by high-power impulse magnetron sputtering on silicon substrates. A focused ion beam was used to cut notched micro-cantilever beams to determine values of fracture toughness and micro-pillars were cut to try and obtain plastic deformation in otherwise brittle coatings. Tests were carried out to 500˚C in-situ using a Nanomechanics inSEM system. Results are explained via DFT modelling of the coating chemistry, and integrated into a cohesive-zone element finite element model.