HOW DO H/E AND H^3/E^2 CONTROL COATING SYSTEM WEAR? – INSIGHTS GAINED FROM ELEVATED TEMPERATURE NANOINDENTATION, SCRATCH AND IMPACT TESTS

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There is a complex relationship between the relationships connecting hardness and elastic modulus - H/E and H^3/E^2 - of coating systems and their wear resistance. Small-scale nanomechanical and tribo-testing at room and elevated temperature has been used effectively to simplify the wear conditions, allowing the role of contact severity, length scale and damage tolerance to be studied to determine when and why coating optimisation strategies are effective, and why they can fail [1].

Results show the importance of relatively low elastic modulus in reducing tensile stresses in sliding/abrasive contact. This is a key factor in why coating design for optimised H/E and resistance to plastic deformation, H^3/E^2, can be more effective than aiming for extremely high hardness. The influence of substrate ductility and load support on the damage tolerance of the coating system in impact tests has been investigated by testing at different contact size (nano/micro/macro). It will be shown that the combination of a coating with moderate hardness, high plasticity index and a tough (i.e. damage tolerant) substrate can improve impact resistance.

The results of the small scale tests show that mechanical and microstructural factors are interlinked and should not be considered in isolation. The role of coating microstructural design in optimising the high temperature mechanical properties of coating systems and their performance in tribologically severe contact conditions such as high speed machining is highlighted.

[1] The influence of the H/E ratio on wear resistance of coating systems – insights from small-scale testing, BD Beake, Surf Coat Technol (2022) 128272; in press.