MICRO-FRACTURE EXPERIMENTS ON NANOCOMPOSITE HARD COATINGS

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Physical or chemical vapor deposited nanocomposite thin films evoke much scientific interest due to their unusual combination of mechanical properties, such as high hardness, high elastic recovery, high elastic strain limit, and high tensile strength. One of the most frequently studied film systems in this context is titanium-silicon-nitride (Ti-Si-N). The self-organized nanostructure consists typically of TiN nanocrystals (nc) covered by an amorphous (a) Si_3N_4 tissue phases. While the exceptional high hardness of Ti-Si-N films and the underlying mechanisms have been studied extensively, less attention has been paid on the fracture toughness.
Here we show experimental results of cantilever bending tests, performed on 2 µm thick reactive magnetron sputtered Ti-Si-N films. We found that nc-TiN/a-Si_3N_4 possesses a significantly higher fracture toughness as TiN, namely K_{IC} values of up to 4.5±0.6 MPa$\sqrt{m}$ in comparison with 1.9±0.4 MPa$\sqrt{m}$ of TiN. This, in combination with a high hardness of 38±2 GPa (TiN: 26±1 GPa), a high fracture strength of up to around 6 GPa, as well as a high elastic recovery and flexibility is an ideal basis for high performance coatings, e.g., used for various industrial applications such as machining. The film nanostructure was carefully studied by independent X-ray diffraction, X-ray photoelectron spectroscopy and high-resolution transmission electron microscopy.