

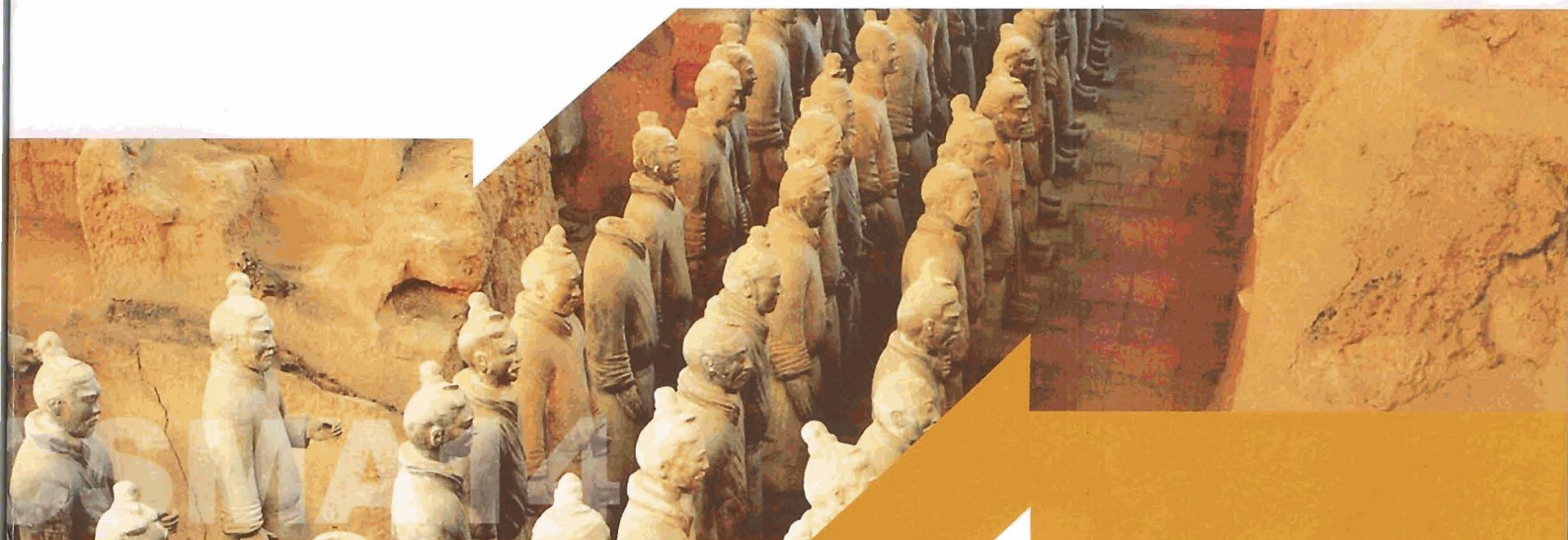
Final Program and Abstracts

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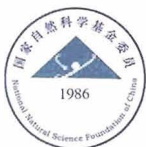
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Effects of Bias on Mechanical Characteristics of Titanium Carbide/Amorphous Hydrocarbon Films

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Abstract

Titanium carbide thin films have excellent hardness, high strength and rigidity, low friction coefficients, low resistivity, and good stability at high temperature, and so the materials are widely used as protective coatings and diffusion barriers. Recently, nano-structured materials and nano-composites such as nc-TiN/a-Si₃N₄, nc-TiC/DLC, and nc-WC/a-C:H have attracted interests. These nano-composite thin films which consist of particles with size of 5-10 nm in a matrix of amorphous materials exhibit enhanced hardness. The TiC/a-C:H films can be deposited by reactive magnetron sputtering, cathodic vacuum arc deposition, and reactive ion beam assisted deposition. The composition affects the structure and properties and for TiC/a-C:H, the maximum hardness is obtained when the titanium concentration is about 40 at.% and the a-C:H phase concentration is about 20%. However, it has been observed that the substrate bias during fabrication has a crucial effect on the mechanical properties of TiC/a-C:H. If the substrate bias is too low or zero, even the TiC/a-C:H films with the appropriate composition does not exhibit enhanced hardness. However, the effects of the substrate have not been investigated in details and the enhancement mechanism is not well understood.

In our experiments, the TiC/a-C:H films were deposited by DC reactive magnetron sputtering at different substrate biases. The substrate was aluminum alloy (2215) with a diameter of 25 mm and thickness of 5 mm. A 200 nm thick titanium interlayer was deposited on the substrate prior to the deposition of the Ti/a-C:H layer 800 to 1000 nm thick. The sputtering target was made of 99.9% pure titanium and 99.99% pure argon gas was used as the work gas and 99.99% pure acetylene as the reactive gas. The substrate bias was individually adjusted to 0 V, -100 V, and -200V. The chemical composition of the films was changed by varying the C₂H₂ partial pressure. The structure and composition of the TiC/a-C:H films were determined by glancing angle X-ray diffraction (GAXRD) and X-ray photoelectron spectrometer (XPS). The hardness and elastic modulus were measured using a nano-indentation tester (CSEM), and the friction coefficients were determined employing a ball-on-disk tribometer. The effects of the substrate bias and the mechanism of the enhancement will be discussed in this paper.

Keywords: TiC/a-C:H films, magnetron sputtering, substrate bias, mechanical properties

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