ICMCTF 2009 San Diego, 27.04-01.05.2009

SYMPOSIUM E - Tribology and Mechanical Behavior of Coatings and Thin Films

E3. TRIBOLOGY OF NANOSTRUCTURED AND AMORPHOUS FILMS

Constitution, microstructure, and tribological properties of nanocrystalline reactive magnetron sputtered V-Al-C-N hard coatings

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The design of carbon-based nanostructured composite coatings being composed of nanocrystalline metastable hard phases such as fcc (Ti,Al)(C,N) homogeneously dispersed in an amorphous carbon matrix or covered by an amorphous carbon grain boundary phase is an emerging new approach for the development of advanced protective coatings. Nanocrystalline V-Al-C-N hard coatings were deposited by reactive r.f.-magnetron sputtering in an Ar/CH_4 plasma. In order to design and deposit different coating microstructures, ranging from metastable solid solutions to multi-phase nanocomposites, a combinatorial materials science approach was applied. In each experiment, six coatings of different composition and/or microstructure were obtained simultaneously by placing six substrates in individual positions relative to a segmented target, composed of ceramic VC and AlN half plates. The CH_4 flow rate was systematically varied up to CH_4 volume fractions of 8 % in the process gas. The chemical composition of the coatings was determined by electron microprobe analysis and the crystal- and microstructure of the films were characterized by X-ray diffraction, scanning and transmission electron microscopy and Raman spectroscopy. The surface topography has been investigated by atomic force microscopy and the correlation with the mechanical and the tribological properties of the coatings was studied by nanoindentation and ball-on-disk tribometer tests against 100Cr6 steel balls. Significant changes in the coatings topography, microstructure and in the related mechanical and tribological properties were observed both as a function of the sample position and of the carbon content. In particular, the successful variation of the hardness (15-35 GPa), the reduced elastic modulus (120-600 GPa) and the friction coefficient (0.15-0.45) on a wide range was achieved and correlated with constitution, microstructure and effective wear mechanisms.