DESIGN CONCEPTS OF LOW-STRESS, STABLE, HARD COATINGS BASED ON MULTINARY TRANSITION METAL NITRIDES

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Transition metal nitride (TMN) thin films are the subject of intense research due to their potential applications in many diverse fields ranging from protective hard coatings, template layers for opto-electronic devices to back electrode contacts for solar cells.

Nowadays, to improve further the functional properties of these materials, the current research strategy is driven by the prospects of synthesizing new ternary or multinary systems, by means of alloying different metal or non-metal elements. Physical vapor deposition techniques, and especially magnetron sputter deposition, have proven to be a versatile, environment-friendly and industrially scalable route to grow such engineered materials. By adjusting the process parameters (e.g., substrate temperature, working pressure, bias voltage, etc.) and tuning the film composition, a wide range of microstructures, including metastable substitutional solid solutions, dual-phase nanocomposites or amorphous alloys, can be tailored in these multi-component systems [1,2].

The present study is a contribution to the design concepts of stable, low-stress, hard (H>20 GPa) TMN-based coatings prepared by reactive magnetron sputtering. The presentation will address the following topics:

- origin of stress development during growth of TMN films. Results using in situ and real-time experiments based on a multiple-beam optical stress sensor will be provided for binary (TiN, ZrN, TaN), ternary (TiZrN, TiTaN, TaZrN) and quaternary (TiZrAlN) systems
- the elastic and mechanical properties of ternary systems obtained by combining experimental techniques (nanoindentation, Brillouin light scattering and picosecond acoustics) and first-principles calculations
- the thermal stability and oxidation resistance, using in situ temperature X-ray Diffraction (XRD)

These results will be discussed based on structural (grain size, texture,) and morphological features obtained from XRD, TEM, SEM and AFM characterizations.

1. P.H Mayrofer, C. Mitterer, L. Hultman, H. Clemens, *Microstructural Design of Hard Coatings*, Progr. Mater. Sci. 51 (2006) 1032
2. J. Musil, *Physical and Mechanical Properties of Hard Nanocomposite films prepared by Reactive Magnetron Sputtering* in "Nanostructured Coatings", A.Cavaleiro, J.Th.M.De Hosson (Eds.) 2006, Kluwer Academic/Plenum Publishers, 233 Spring Street, New York, NY 10013, U.S.A., pp. 407-463