19th INTERNATIONAL CONFERENCE ON DIFFUSION IN SOLIDS AND LIQUIDS
DSL2023
HERAKLION, CRETE | GREECE
26-30 JUNE 2023

ABSTRACT:

Structure and Mechanical Properties of Ta/Tan Nanolayered Systems

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Designing new materials (more efficient, more durable and require less raw material consumption) is a fundamental task of materials engineering. In many modern applications, increasing durability and reducing the amount of material used is achieved by strengthening and functionalizing the surface. Despite many years of research, the amazing mechanical resistance exhibited by nanoobjects is only (partially) explained in the case of crystalline metals and alloys, while in the case of other materials it remains a mystery, so the aim of our research is to investigate the mechanism of improving the mechanical properties of Ta/TaN nanolayered systems. Usually, the increase in the hardness of the coatings is associated with the deterioration of their ductility. In the case of the multilayer nanostructure, different behavior is observed.
The material for the study is the Ta/TaN layered systems obtained using the ALD (Atomic Layer Deposition, R200 from Picosun) technique. The mechanical properties were determined using the nanoindentation technique, which consists in inserting an indenter perpendicularly to the surface of the tested material. The obtained dependence of force as a function of displacement characterizes the material's response to deformation and allows to determine many nanomechanical parameters of the material, such as Young's modulus and instrumental hardness. Electron microscopy (HR STEM, EDS, EELS) was used to study the structure (both before and after nanoindation) and deformation mechanism of Ta/TaN nanocoatings. Thanks to this, it is possible to create and compute the numerical model of the indentation (using methods appropriate to the degree of structure defect) and compare with the results of experimental tests.