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Nitrogen effect on the properties of TiN films deposited by DOMS

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The properties of TiN films deposited by DCMS (Direct Current Magnetron Sputtering) strongly depends on the N_2 content in the discharge gas since the energy flux per deposited particle increases with nitrogen addition. Randomly out-of-plane oriented films with faceted grains are deposited at low N_2 gas flow. Increasing the reactive gas content successively leads to the deposition of [111] and [002] out-of-plane oriented films. The energy flux per deposited particle depends mainly on the compound formation energy, the energy of the sputtered particles after transport through the gas phase, and the energy flux due to electrons and ions hitting the substrate. Although the energy flux due to kinetic energy of neutralized and reflected particles can be neglected in DCMS, the higher discharge voltage used in HIPIMS (High Power Impulse Magnetron Sputtering) may change the role of these particles in the deposition process. In fact although the energy of the metallic ions is too low to induce intrinsic stress, stress induced-defects are still created in TiN films deposited by HIPIMS, suggesting additional energetic ions or neutral atoms impinge on the growing film during deposition.
In this work TiN films were deposited by Deep Oscillation Magnetron Sputtering (DOMS), a variant of HIPIMS which uses impulses with high peak voltage (> 1000 V) and thus more prone to the effect of neutralized and reflected particles. The crystal structure of the films was obtained by X-ray diffraction (XRD) both in symmetrical and asymmetrical geometry. EDS and XPS were used to elucidate the chemical composition of the films and the nature of the chemical bonding, respectively. The microstructure of the films was characterized by SEM and their mechanical properties were measured by nano-indentation.

Keywords
DOMS
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XRD
residual stress