Oblique angle co-sputtering of nanostructured Ti-W thin films: Influence of deposition current on structure and electrical properties

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In the present work, Ti-W thin films were deposited on glass and (100) silicon substrates by DC magnetron co-sputtering. Films were prepared by the glancing angle deposition method by fixing the deposition angle to 80° for both targets. Ti and W target currents, namely I_{Ti} and I_W, were systematically and reversely changed from 0 mA to 300 mA, to tune the composition of the films. All other working parameters were kept constant. For all co-sputtering conditions, the deposition time was adjusted in order to get a film thickness close to 400 nm. A columnar microstructure was obtained with a Janus-like architecture as a function of the operating target currents. Different morphologies were observed between the two opposite sides of the columns. Surface and cross-section views of Ti-W thin films were observed by scanning electron microscopy (SEM). The chemical composition was determined by energy-dispersive X-ray spectroscopy (EDX). Evolution of the films crystallographic structure was also investigated by X-ray diffraction. Electronic transport properties of Ti-W films co-deposited on glass substrates were studied measuring DC electrical resistivity ρ as a function of the temperature T from 7 K to 300 K. The electron-phonon and electron-defect interactions were investigated from the ρ *vs.* T measurements and correlated with variations of the film's composition and structure. Ti and W atomic concentrations exhibited a symmetric evolution as a function of each target current. Using I_{Ti}/I_W = 55/245 mA, films presented equimolar Ti and W concentrations. DC electrical resistivity *vs.* temperature was strongly influenced by the reverse change of target currents. These metallic-like behaviors are directly connected to the atomic concentration of elements in the films, grain size, phase occurrence and voided microstructure.