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Effect of substrate temperature and annealing on structure, stress and properties of reactively co-sputtered Ni-TiN nanocomposite thin films

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Abstract

Nanocomposite thin films with TiN dispersed in Ni matrix were deposited in an environment having Ar:N_2=1:2 on silicon (100) substrate with bias of -60 V at 300 ^{o}C, 500 ^{o}C or 700 ^{o}C by co-sputtering of Ti and Ni targets used as RF and DC sources, respectively. The structure and properties of these films were compared with those deposited at ambient temperature and then annealed for 1 h in vacuum at above-mentioned temperatures. Whereas <111> is the preferred orientation of Ni, transition from <100> to <111> is observed for TiN at temperatures ≥500 ^{o}C, as confirmed by XRD analyses. The average grain sizes of Ni and TiN have been found to be in the ranges of 11-25 nm and 6-13 nm, respectively, using both XRD and TEM studies. Transition from compressive to tensile residual stress is observed with increase in substrate temperature for deposition or annealing. Hardness, elastic moduli and scratch-resistance of the films evaluated using a nanoindentor are found to possess the most optimum values on their growth at substrate temperature of 300 ^{o}C.

Keywords: *Nanocomposite thin films; reactive magnetron sputtering; substrate temperature; annealing; surface roughness; residual stress; nanoindentation hardness, nanoscratch*

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