Abstract

The main aim of this thesis is to investigate the effect of process parameters on the properties of Ni, Ti and co-deposited Ni-Ti thin films deposited on Si (100) substrate produced by magnetron sputtering of individual Ni and Ti targets by DC and RF sources, respectively. The deposition parameters *viz.*, Ar gas pressure, target power, substrate-target distance and substrate bias voltage was found to affect the deposition rates of Ni and Ti films, respectively. Substrate-bias voltage was found to affect the crystallinity and led to the change of preferential orientation of Ti grains from (10*0) to (00*2) supported by texture pole figure analysis. Formation of titanium silicides at higher deposition temperature (500 °C) was found to cause strain in Ti lattice. In Ni depositions, the formations of nickel silicides were observed for post-annealing at 500 °C by diffusion of Ni atoms into the Si substrate forming a triangular diffusion fronts at the film-substrate interface.

With the knowledge gathered during elemental depositions, co-deposition of Ni and Ti was performed by keeping equal deposition rates for Ni and Ti (~ 11 nm/min) which eventually led to partially crystalline Ni-30at%Ti films. However, the ratio of Ni and Ti deposition rates of 2:3 successfully yielded near-equiatomic Ni-Ti films with ~1 μm/h deposition rate which were predominantly amorphous in nature. However, the extent of amorphousity in films was found to be increased with addition of excess Ti in Ni-Ti films due to increase in negative heat of formation, signifying that the glass forming ability in Ni-Ti films increases with Ti content. In order to evaluate the effect of ion-bombardment on $Ni_{100-x}Ti_x$ (x=0, 50, and 100) films, films were deposited on Si substrate held at room temperatures at substrate-bias voltage of 0, -50 and -100 V. $Ni_{100-x}Ti_x$ (x=0) films were not affected by substrate-bias voltage, whereas $Ni_{100-x}Ti_x$ (x=100) film crystallinity, preferential orientation of grains along with the morphology of grains were considerably affected with increase in substrate bias voltage. Interestingly, $Ni_{100-x}Ti_x$ (x=50) films showed slight improvement in the film crystallinity accompanied with surface modification.

The as-deposited Ni-Ti films showed temperature of crystallization at 471 °C. Different mode of heat treatment procedures were adopted (i) Annealing outside the deposition chamber in an isolated furnace, (ii) Annealing inside the deposition chamber. Former procedure, showed increase in number of metastable precipitates like Ni_4Ti_3, Ni_3Ti and $NiTi_2$ along with the presence of B2 and B19' phases with increase in annealing temperature from 400 to 700 °C. The films exhibited martensitic transformation at near or just above the room temperatures with a narrow hysteresis range. In addition, the hardness and depth recovery improved with annealing temperature suggesting good shape recovery of Ni-Ti films after deformation. Another set of Ni-Ti films before subjecting to annealing inside the deposition chamber were deposited on Si at 300 °C (SA) or were deposited with bias voltage of -100 V at room temperature (BA). Various studies revealed that SA film exhibited precipitation of Ti_2Ni phase along with presence of twin martensitic bands. However, BA film was found to contain grain sizes less than SA film exhibiting higher resistance to wear. The martensitic transformations was observed to occur at temperatures below the room temperature suggesting that these films show shape memory behavior at cooled environments.

Keywords: Magnetron, **s**puttering, Thin films, Crystallinity, Morphology, Texture, Pole figure, Hardness, Ion-bombardment, Annealing.