Abstract

The present research work is provoked by the remarkable properties of functional nanometer scale materials. Tailoring properties of such practical materials at nanometer scale has been a goal of great interest in material science research. The most attractive approach is to design layer by layer artificial thin film structures. This work reports the successful attempts to grow Ag-Ni multilayers and Sm-Co thin films at nanometer scale by using DC magnetron sputtering. The experimental results show the successful growth of polycrystalline Ag/Ni multilayers at room temperature and $SmCo_5$ amorphous films. Ag/Ni multilayers have got considerable interest in recent years by virtue of their technological applications in giant magnetoresistance (GMR) sensors and perpendicular magnetic recording media. On the other hand, $SmCo_5$ is an appropriate material for many applications, such as high-performance permanent magnets and high-density data storage media. Following four types of experiments were carried out:

In first experiment, Ag/Ni multilayers have been grown on oxidised Si (100) substrates by DC magnetron sputtering at room temperature. The Ag thickness is varied in the range 2.5–20 Å. A combination of X-ray reflectivity, diffraction and transmission electron microscopy show that the films have excellent layering for all Ag thicknesses. This is due to the use of an amorphous AlZr wetting layer which promotes smooth, layered growth of the Ag and Ni. The results demonstrate the feasibility of growing good quality multilayers of high mobility metals on oxide substrates without substrate cooling.

In second experiment, the thickness dependence of magnetic properties has been studied in $SmCo_5$ amorphous films with imprinted in-plane anisotropy for thicknesses ranging down to the nanometer scale (2.5 – 100 nm). The field induced in-plane magnetic anisotropy decreases considerably when the film thickness is below 20 nm. Analysis of the magnetic anisotropy energy shows that the decrease of the induced in-plane anisotropy is accompanied by the development of an out-of-plane interface anisotropy. Two different regimes for the coercivity (H_c) change are found: below 3.75 nm, the H_c decreases continuously with decreasing the film thickness, whereas at above 3.75 nm, the H_c decreases with the increase of the film thickness. This change in H_c can be understood by considering the decrease of the short-range chemical order for the thinnest films (<3.75 nm) and the relative decrease of the interface contribution with increasing film thickness. The changes in anisotropy have profound influence on the domain structure, in which the angle of the zigzag domain boundaries decreases with the inverse thickness of the layers.

In third experiment, Polycrystalline Ni thickness dependent Ag/Ni multilayers were grown by DC magnetron sputtering at room temperature on Si (100) substrates annealed at 550 °C. The

iickness of Ni layer was varied in the range 5–25 Å. X-ray reflectivity, X-ray diffraction and ransmission electron microscopy showed that the films had excellent layering for all Ni iicknesses. It was possible just because of the use of an amorphous AlZr buffer (wetting) layer vhich facilitated smooth and layered growth of the Ag / Ni multilayers. The results have stablished the viability of growing good quality multilayers on oxide substrates at room emperature.

In fourth and final experiment, Ag/Ni multilayers of equal Ag and Ni thickness were grown by)C magnetron sputtering on Si (100) substrates at room temperature. The substrates were baked at 50 °C. The structural and magnetic properties of Ag/Ni multilayers were investigated by using X-ay reflectivity, X-ray diffraction, transmission electron microscopy (TEM) and magneto optic Kerr ffect (MOKE). Moreover, the structural and magnetic properties of sputtered Ag/Ni multilayers vere investigated as a function of annealing treatment.