Comparison of the Stress and Magnetic Properties of Laminated FeCo/Ru and FeCo/NiFe Thin Films for Write Pole Applications

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Introduction

❑Soft high moment $Fe_{65}Co_{35}$ (FeCo) films are potential candidates for write head applications for high density magnetic recording.

❑Sputtered FeCo films show high coercivity with no distinct uniaxial anisotropy, as well as large magnetostriction. The use of seed layers, for instance, Ru, improves the soft properties significantly by reducing the grain size [H. S. Jung and W. D. Doyle J. Appl. Phys., 93, 6462 (2003).].

❑FeCo thin films laminated with Ru or NiFe have been investigated with a view to minimizing the overall stress and resultant magnetostriction.

❑We have studied the magnetic properties and stress of laminated Ru/FeCo and NiFe/FeCo thin films as a function of layer structure and deposition conditions.

Experimental Details

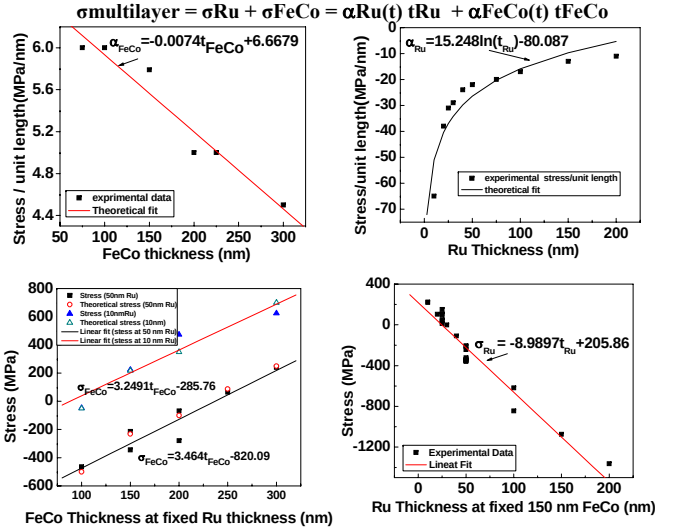
- [lamination layer/FeCo]$_N$, N=1, 2, 3, 4, 5, 10 etc..
- Conventional DC magnetron sputtering
- Target: $Fe_{65}Co_{35}$, Ru, NiFe
- Base pressure: <5 $\times 10^{-7}$ Torr
- 300 Oe magnetic field in the film plane during deposition to induce uniaxial anisotropy.

Deposition conditions

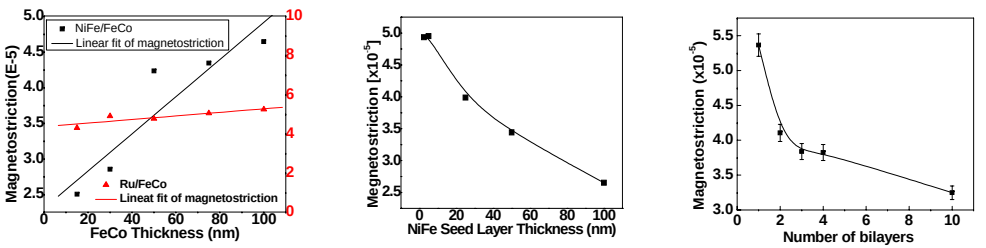
- Ru, NiFe and FeCo depositions were done with power of 80-150 W and 3mTorr Ar gas pressure.
- Single Ru(10nm)/FeCo bilayers with varying FeCo deposition from 1.5 mTorr to 10 mTorr.

Stress and Magnetic Properties of Laminated Ru/FeCo Multilayers

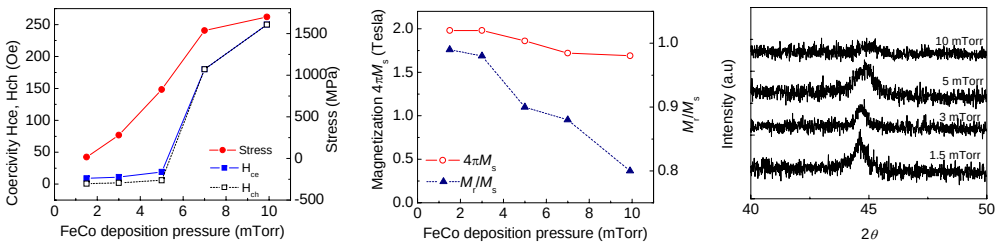
$\sigma multilayer = \sigma Ru + \sigma FeCo = \alpha Ru(t)\, tRu + \alpha FeCo(t)\, tFeCo$



Comparison of Magnetostriction for Laminated Ru/FeCo and NiFe/FeCo Multilayers



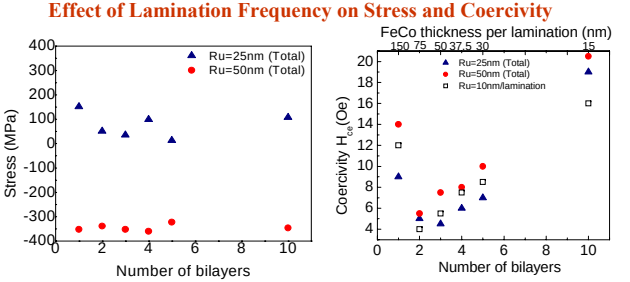
Stress, Coercivity and XRD for Ru/FeCo as a function of deposition pressure



➢The (tensile) stress and coercivity of a Ru/FeCo bilayer increases as a function of deposition pressure. The film deposited at 10mTorr shows high coercivity (~ 250 Oe) and becomes isotropic, while one deposited at 3 mTorr has low coercivity and high uniaxial anisotropy . The magnetization and crystallinity deteriorate as the deposition pressure increases.

➢Excellent easy-axis and hard-axis coercivities of 4 Oe and 0.5 Oe, respectively, can be achieved by deposition of both -Ru and FeCo layers at low power and pressure

Effect of Lamination Frequency on Stress and Coercivity



➢Laminated Ru/FeCo multilayers were studied as a function of lamination thickness and frequency. The stress depends only on the total thickness of the individual materials, independent of the number of laminations , so we can tailor individual thicknesses to minimize the overall stress

➢Magnetostriction for laminated Ru/FeCo multilayers do not depend on either number of lamination or lamination thickness (only slightly depend on FeCo thickness). While NiFe lamination can significantly reduce the resultant magnetostriction.

➢The coercivity, magnetization and magnetostriction of Ru/FeCo do not appear to be related to the intrinsic stress in the films for the range studied.

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