A Study of Damping, Magnetoelastic Properties, and Nitrogen Content in FeTiN Films

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Introduction

We have found that the anisotropy of FeTiN films is stable at small substrate-target sputtering distances for Nitrogen content below 6%. (Y. Ding, S-C. Byeon and C. Alexander, Jr., IEEE Trans. Magn 37, 1776 (2001)).

We have prepared stable films and are investigating the effects of structure and elastic effects on the LLG damping constants in stable films as a function of Nitrogen content.

Experimental techniques include VSM, FMR, XRD, XPS, magnetostriction, stress, and permeability measurements.
XRD and Thermal Stability Measurements of FeTiN Films with Different Nitrogen Concentrations

at% N in FeTiN
18.86 at% N
15.39 at% N
13.51 at% N
11.16 at% N
11.99 at% N
9.88 at% N
8.51 at% N
6.76 at% N
6.05 at% N
5.33 at% N
2.95 at% N
0.00 at% N

Rotation of Hk after 1hr 100°C DC PTA

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FeTiN Magnetostriction

FeTiN Magnetostriction versus N%
Permeability Data

FMR Data

\[ f = \gamma \sqrt{(H + H_k + 4\pi M_s)(H + H_k)} \]
FeTiN 0% N

$\Delta H = \Delta H_0 + 1.16 \frac{\alpha f}{\gamma}$

$\alpha = \alpha_0 + \frac{\Delta H_k}{\sqrt{M_s} \sqrt{H_k + H_b}}$

FeTiN 6-05%

$H_0 = 111$ Oe

$M_s = 1384$ emu/cc

$\alpha_0 = 0.0047$

$\Delta H_k = 1.8$ Oe

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$\Delta H_0$ and $\alpha_0$ Values vs. Nitrogen Content
Conclusions and Future Studies

Our initial experiments show a correlation between sample inhomogeneities, as represented by the $\Delta H_0$ value, and the sample magnetoelastic properties.

We are preparing samples for TEM measurements to investigate the grain size as a function of Nitrogen content.

We will be using optical techniques to investigate correlations between sample volume, inhomogeneities and damping constants.