Static and dynamic magnetic properties of amorphous and crystalline CoFeB-based trilayers

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Abstract:
We have investigated the influence of the structural transition from amorphous to crystalline in Co₅₆Fe₂₄B₂₀ trilayers on static and dynamic magnetic properties. FMR data from 7-40GHz were obtained using shorted waveguides. The FMR results suggest an increase in damping with decreasing film thickness, which is more significant in annealed samples. VSM data indicate an increased coercivity after annealing, more prominent with decreasing thickness. This suggests crystallization of Co₅₆Fe₂₄B₂₀ after annealing to a CoFe alloy, which is confirmed by XRD analysis.

Sample preparation:
• Magnetron sputtering
  • Magnetic field during growth ~1000e
  • Base vacuum: 3x10⁻⁷ Torr
  • Ar pressure: 3-5 mTorr
1. Substrate/Ru(20)/CoFeB(t)/Ru(20)
2. Substrate/Ta(20)/CoFeB(t)/Ta(20)

Easy axis M(H) with VSM before annealing
Ru(20)/CoFeB(t)/Ru(20) Ta(20)/CoFeB(t)/Ta(20)

Ru and Ta have no significant effect on Hc and Ms of as-deposited CoFeB

Easy axis M(H) - after 1hr @ 525°C
Ru(20)/CoFeB(t)/Ru(20) Ta(20)/CoFeB(t)/Ta(20)

Observed Ms is lower at 525°C than at 375°C
Observed Ms is higher in Ta/CoFeB(t)/Ta at 525°C

Conclusions
• Observed decrease of Ms and increase in Hc upon annealing
• Transformation from amorphous CoFeB to crystalline CoFe.
• Ru interdiffuses into CoFeB more than Ta after annealing
• Ru effectively enhances crystallization.
• q observed to be decreasing with increasing thickness.
• Meff increases with thickness.

Effective magnetization:

We measure the field derivative of complex susceptibility (χ'') From FMR we obtain:
• Gilbert damping α
• Gyro-magnetic ratio γ
• Line width ΔH
• Effective magnetization Meff
• Surface anisotropy Ks

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