



Self-bias ferromagnetic resonance and quasi magnetic isotropy of $[\text{FeCo-B/MgO}]_6$ multilayers prepared by composition gradient sputtering

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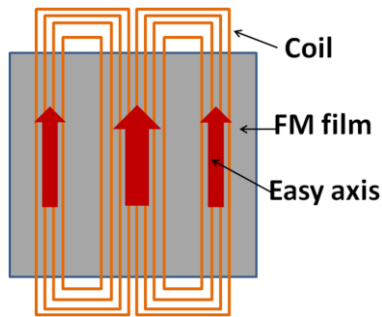
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Introduction

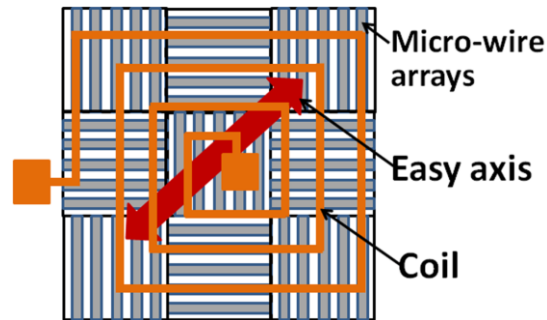
A well-defined in-plane uniaxial magnetic anisotropy (UMA) is necessary to reach a high f_{FMR} . A high permeability is only available at HA excitation. This restricts the efficiency of soft magnetic films to 50% only for the UMA SFMs.

Q: How to realize 100% Hard-axis excitation of magnetic films in the high-frequency micro-magnetic inductors ?

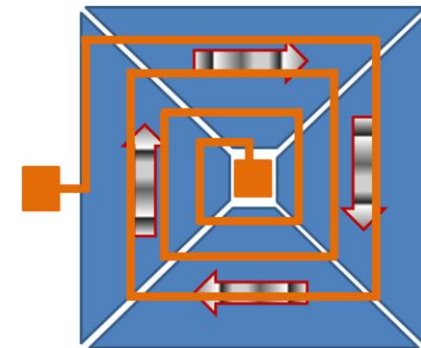
Some solutions^[1-7]:



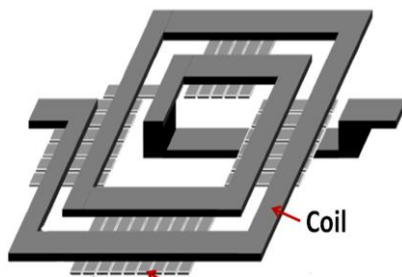
(a) Rectangle coils



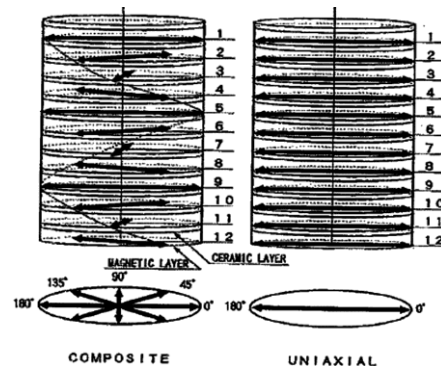
(b) Bidirectional UMA(I)



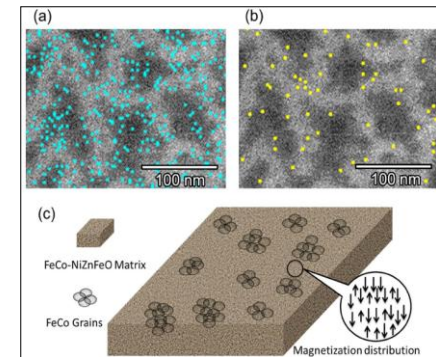
(c) Bidirectional UMA(II)



(d) Patterned SMFs



(e) Composite anisotropy



(f) Omnidirection SMFs

The fabrication of CGS multilayers

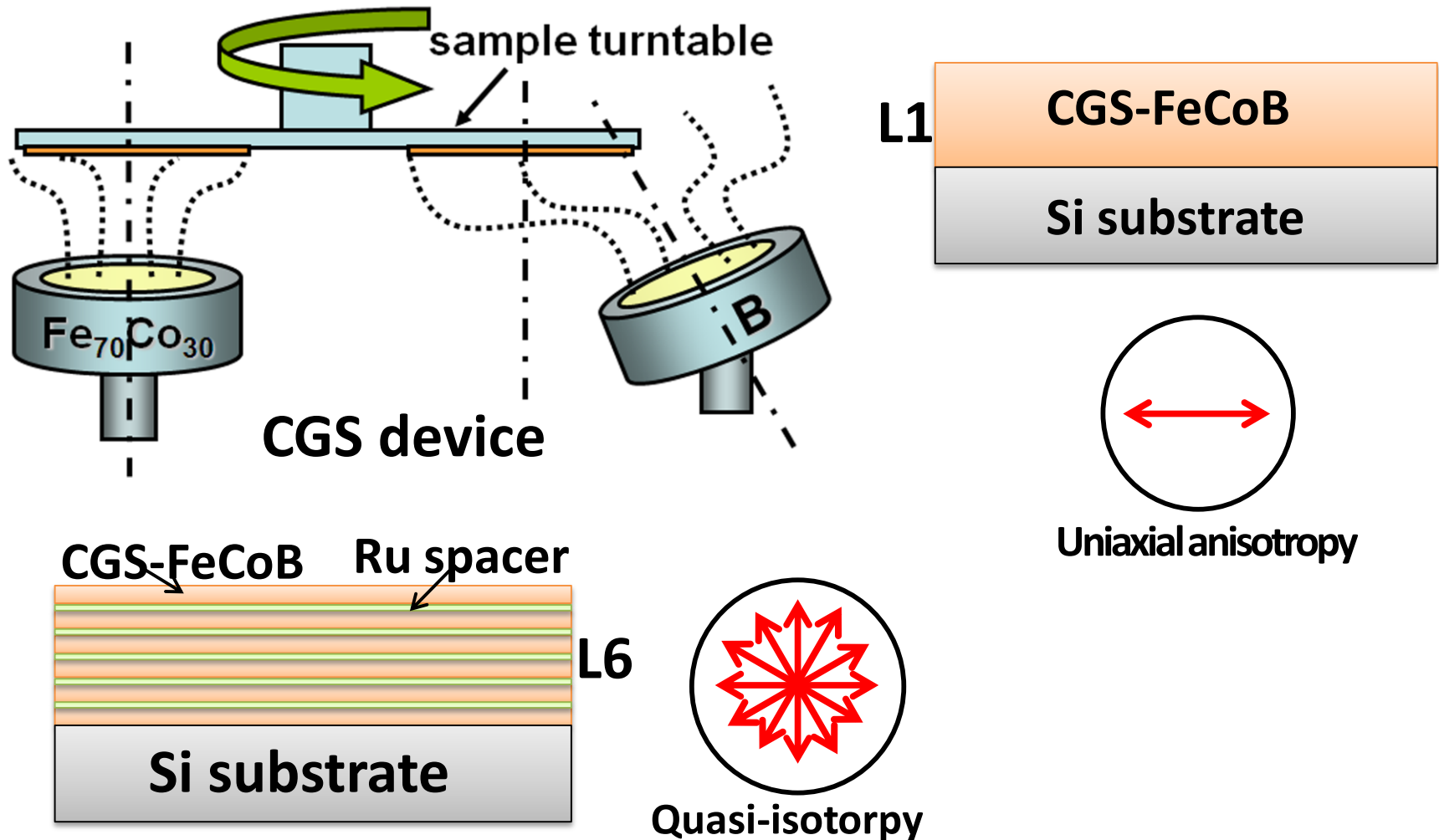


Fig. 1. CGS device, multilayer structure and the orientation of easy axis for CGS-FeCoB sublayers.

Results and discussion

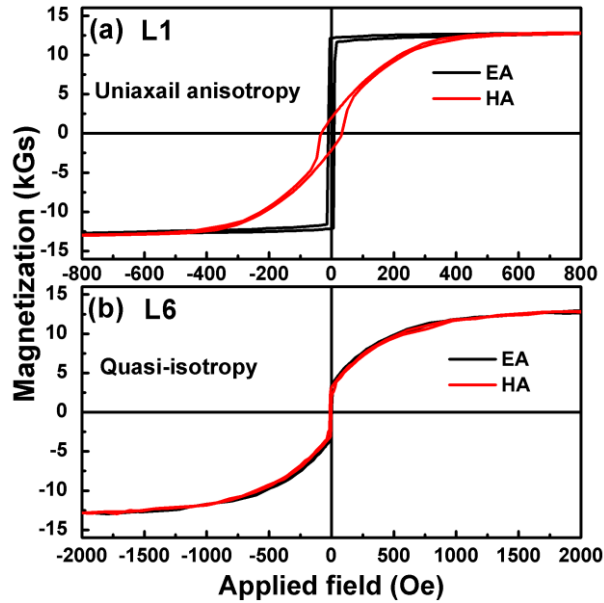


Fig. 2. The hysteresis loops for (a) L1 and (b) L6.

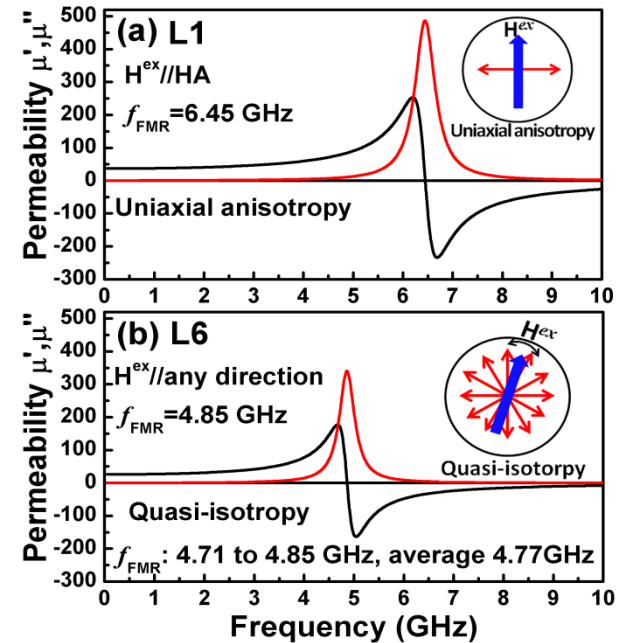


Fig. 3 The self-bias permeability spectra at zero magnetic field for samples (a) L1 and (b) L6.

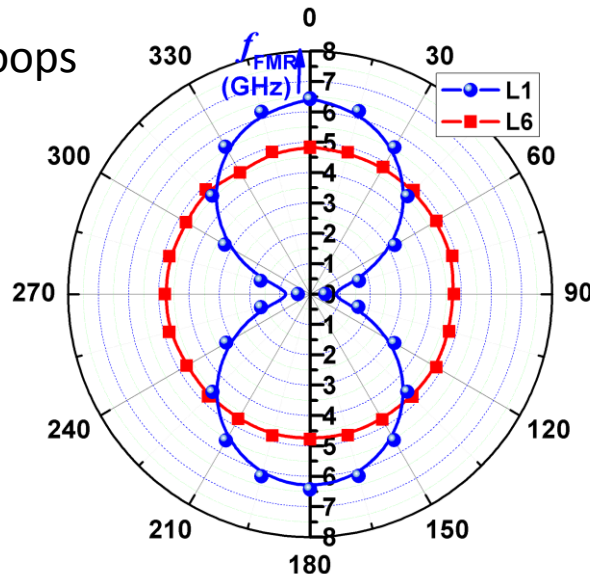


Fig. 4. The angle dependence of f_{FMR} for L1 and L6.

Conclusions

- A well-defined uniaxial magnetic anisotropy (UMA) about 400 Oe and f_{FMR} of 6.45 GHz were achieved in $\text{Fe}_{0.7}\text{Co}_{0.3}$ -B single layer prepared by composition gradient sputtering.
- Quasi-isotropic magnetic properties and microwave performances with f_{FMR} around 4.77 GHz were obtained in a designed multilayer laminated by the UMA $\text{Fe}_{0.7}\text{Co}_{0.3}$ -B sublayers with the easy axis of neighboring sublayer successively rotating 30° in film plane.
- The exchange coupling between the ferromagnetic sublayers and the average effect of ferromagnetic sublayers in the multilayer are responsible for the omnidirectionality of the magnetic and microwave performances.

References:

1. T. Sato, et al., IEEE Trans. Magn., 30 (1994) 217.
2. C.S. Kim, et al., IEEE Trans. Magn., 37 (2001) 2894.
3. M. Yamaguchi, et al., IEEE Trans. Magn., 36 (2000) 3514.
4. B. Viala, et al., IEEE Trans. Magn., 41 (2005) 3544.
5. W. Ni, et al., IEEE Trans. Magn., 42 (2006) 2827.
6. E. Sugawara, et al., J. Appl. Phys., 73 (1993) 5580.
7. G. Chai, et al., Sci. Rep., 2 (2012) 832.

Acknowledgement: This work was financially supported by NSFC 11074040, ZR2012FZ006.

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