MAGNETISATION SWITCHING AND DYNAMICS IN RARE EARTH BASED EXCHANGE-SPRING MULTILAYERS

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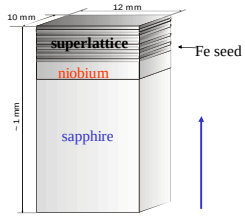
INTRODUCTION

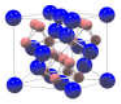
✓Exchange Spring multilayers have a lot of applications, e.g. permanent magnets, MEMS & magnetic data storage (Read Heads, Hard disk drives,…)
✓The magnetization dynamics for rare earth exchange spring systems can be used to reveal their switching behaviour, relaxation times , bending fields etc.
✓Broadband Ferromagnetic Resonance is a successful tool for the characterization of magnetic films in the microwave range ~ 0.5-50 GHz.
✓High frequency measurements for sample in dimensions of sub-micron require a precise technique, i.e., Vector Network Analyzer Ferro-magnetic Resonance (VNA-FMR).

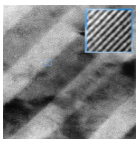
MATERIALS



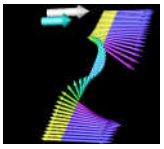
[110] growth direction

Cubic structure of of RFe_2 Laves phase superlattices





Atomic cross section (below) of $DyFe_2$ / YFe_2 superlattices grown using the Oxford MBE Facility (above), (R C C Ward.)



Computer simulation of an exchange spring in a $DyFe_2$-YFe_2 multilayer. The soft YFe_2 layer is in the middle.

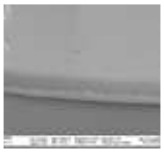
METHODS

Landau-Lifshitz-Gilbert equation of motion for magnetic precession:

$$\frac{d\vec{M}}{dt} = -\gamma\left(\vec{M} \times \left(\vec{H} + \vec{H}_{eff}\right)\right) + \frac{G}{\gamma M^2}\left[\vec{M} \times \frac{\partial \vec{M}}{\partial t}\right]$$

The VNA-FMR technique allows operation over a wide frequency band. The FMR parameters are obtained via standard microwave *S*– parameter measurements, as a function of applied frequency and field.

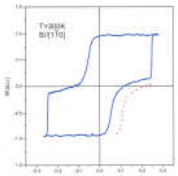
Coplanar Waveguide (CPW) used to drive FMR measurements in range from 1-40 GHz



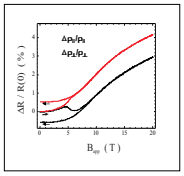
The CPW was manufactured, in house, using a combination of e-Beam Lithography (EBL) and lift-off processes (A.R. Buckingham.)

RESULTS

1. MOKE and GMR Results

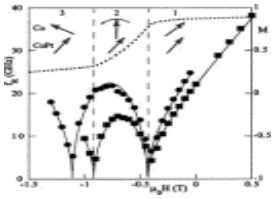


MOKE (Magneto-Optical Kerr Effect) have been used to locate the exchange spring field region of interest (110) DyFe2-YFe2 multilayer at room Temperature. (D. Wang)



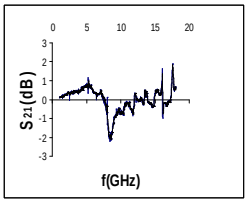
Giant magneto-resistance by exchange spring magnetic structures

2- Theoretical model for FMR



FMR theoretical calculations have been carried out for a simple exchange spring system, Co-Fe, (Stamps et al APL (93)2003. They report two low frequency absorption peaks associated with spin- flops.

3- VNA-FMR Results for Preliminary Ferrite Samples



The measured Scattering Parameter (S_{21}) for Ferrite sheet at Room Temperature.
At B = 436 mT, the resonance frequency ~ 8.6 GHz.

CONCLUSIONS

1- The VNA-FMR technique and coplanar transmission line can be used to exploring magnetic exchange spring behaviour.

2- A preliminary investigation to developing a VNA-FMR technique in order to study the exchange spring multilayers is done.

3-The current arrangement has yet to be calibrated with DPPH.

ACKNOWLEDGMENTS

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