Optically induced dynamics of ferromagnetic exchange spring multilayers

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Ferromagnetic exchange spring multilayers have attracted great interest as potential high-density recording media. By combining the magnetic properties of the magnetically hard and soft constituent layers these materials can show increased thermal stability compared to single-phase media [1] and can be engineered to yield low coercivity [2]. Here we report time-resolved magneto-optical Kerr effect measurements, which show, to the best of our knowledge, the first time domain observations of precessional magnetisation dynamics induced by an exchange spring.

A $[DyFe_2\ (20\,Å)/YFe_2\ (80\,Å)]_{x40}$ multilayer film was fabricated by molecular beam epitaxy [3]. The layers form in the C15 $MgCu_2$-type cubic Laves phase. In zero applied field the superlattice forms a giant ferrimagnetic state with anti-parallel net moments in adjacent $DyFe_2$ and YFe_2 layers. In applied fields, clear exchange spring behaviour has been observed using the conventional magneto-optical Kerr effect (MOKE). The all-optical, time-resolved, magneto-optical Kerr effect (TRMOKE) measurements were performed using an amplified Ti:sapphire pulsed laser. An oscillatory TRMOKE signal, shown in Fig. 1(a) was observed following absorption of the laser pulse. The frequency of the oscillation was found to increase with bias field (Fig. 1(b)), indicating ferromagnetic resonance.

It is believed that the torque exerted by the wound exchange spring induces magnetisation precession. Precession is only observed at field values above the bending-field transition, when the sample exists in a wound exchange spring state. Heating by absorption of the ultrafast laser pulse causes demagnetisation and moves the magnetisation away from equilibrium.

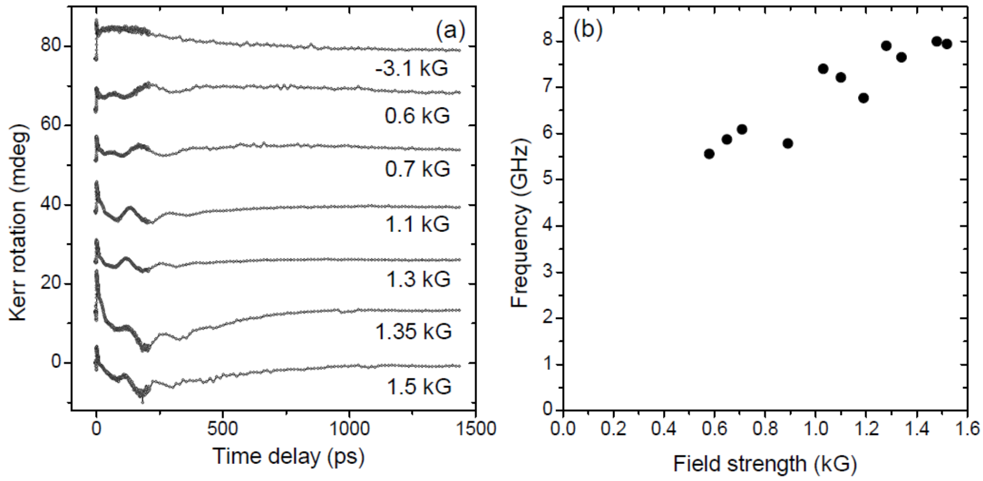

Figure 1 – (a) shows TRMOKE scans made with varied bias field applied parallel to the $DyFe_2$ easy axis. (b) shows the peak frequencies obtained by fast Fourier transform of the data in (a).

References

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