Session CE
INSTRUMENTATION AND MEASUREMENT TECHNIQUES

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Tuesday Afternoon 2:00 **Rivers**

2:00

CE-01 Picosecond Pulsed Magnetic Fields for Studies of Ultrafast Magnetic Phenomena

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Pulsed photoconductive gating of microlithographic coplanar transmission line structures on semiconductor substrates is used to produce quasi-step-function magnetic field transients for application to time-resolved investigations of a wide variety of ultrafast magnetic phenomena. Typical fields generated using a synchronously pumped, subpicosecond dye laser have risetimes of order 1 picosecond, durations of several hundred picoseconds, and magnitudes in the range of tens of Gauss. These parameters are largely determined by characteristics of the substrate material, in particular the mobility, carrier lifetime, and dielectric strength, which may be tuned (for example by ion implantation) to suit specific applications. The magnitudes and temporal profiles of the fields are monitored both magneto-optically and through time-resolved photoconductivity cross-correlation measurements. The fields may be applied either in-plane or normal to thin film samples. An illustration of the technique in an investigation of the ultrafast spin dynamics of Tb-doped EuS films[1] is presented.

1. R.J. Gambino, R.R. Ruf, T.R. McGuire and P. Fumagalli, this conference.

2:12

CE-02 THE USE OF MAGNETIC FORCES IN THE ALIGNMENT OF A RADIAL FIELD SUPERCONDUCTING MAGNET

W.L. Tew, P.T. Olsen, E.R. Williams and C.G. Kim†, National Institute of Standards and Technology, Gaithersburg, MD 20899

Modern determinations of the SI watt involve the comparison of a known mechanical force with a well characterized magnetic force[(1)]. The NIST watt experiment uses a fixed superconducting magnet, with a constant radial field, that produces a vertical force on a suspended, current carrying coil[(2)]. In order that all relevant measurements be made to the desired accuracy of 0.1 ppm, the fixed magnet must be highly stable in several respects. First, the current through the superconductor must be held constant to within 0.1 ppm. In addition, the dimensions of the magnet windings must be mechanically stable to this same precision. Finally, the alignment of the magnet's force field with respect to the suspended coil axis should be held constant to within 400 μradians or better.

Specifically, any deviation from ideal alignment results in small, non-vertical magnetic forces and torques exerted on the suspended coil. We use these forces and torques to monitor and correct for changes in alignment via an optical measurement system. This system detects small changes in the horizontal position of the suspended coil upon reversal of a known current. These displacements are then analyzed to determine the magnitude and direction of the non-vertical forces and torques.

The degree of misalignment is then inferred from simple modeling of the coil suspension. Our system typically has a coil displacement resolution of ±25 μm corresponding to horizontal forces of ±100 ppm of the applied vertical force. We are thus able to monitor changes in the magnetic alignment to the nearest 100 μradians. Results are compared with calculations.

1. B.P. Kibble, in *Atomic Masses and Fundamental Constants*, 5, 545, J.H. Sanders and A.H. Wapstra, eds., Plenum, New York, (1976).
2. W.Y. Chen *et.al.*, in *Advan. Cryo. Eng.*, 27, 97, (1982).
† Guest Scientist from the Korean Standards Research Institute

2:24

CE-03 MULTI-DIMENSIONAL DETECTION OF MAGNETIC FIELDS USING CMOS INTEGRATED SENSORS

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Recently designed magnetic field sensors have enabled the detection of magnetic fields for essentially two situations. For one-dimensional sensing, magnetic fields either parallel or perpendicular to the chip surface can be detected, while for two-component detection, the field orientation is generally restricted to be along the chip surface. Here, we present a novel CMOS silicon structure based on a vertical Hall device which is capable of detecting the x-, y-, and z-components of magnetic field.

The fabrication of magnetic field sensors (MFS) employing a standard integrated circuit process offers numerous advantages. Besides the obvious reduction in overall size, it also allows a low unit cost for high volume production, and provides the potential to integrate sensor support circuitry on the same chip. Aside from this, a significant benefit of basing the vertical Hall MFS design on semiconductor technology is that the generated Hall voltage is inversely proportional to the carrier concentration, as is prevalent with silicon in comparison to metals.

The device is fabricated in a standard 2 μm CMOS process and consists of five current contacts and four pairs of split-Hall contacts. Upon the application of a magnetic field, detection of B_x, B_y, and B_z is accomplished by measuring the difference between the appropriate Hall probe points.

The experimental results show the response of the device (Hall voltage) to be linear for any applied magnetic field component. Our paper will provide a detailed discussion on magnetic field sensor operation and present a full analysis of the results.

2:36

CE-04 GENERALIZED TORQUE ANALYSIS OF MAGNETIC UNIAXIAL ANISOTROPY

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A new method for analyzing uniaxial torque data has been developed based upon the well known 45° method. When a magnetic field H is applied at an angle α with respect to the plane of a thin film, the magnetization M will reach equilibrium at an angle β with respect to the plane. The equilibrium position of M is given by the following equation (to second order)

$$MVH\sin(\theta) = 2K_1V\sin(\alpha-\theta)\cos(\alpha-\theta) + 4K_2V\sin^3(\alpha-\theta)\cos(\alpha-\theta), \quad (1)$$

where θ is the angle between H and M ($\theta = \alpha-\beta$) and V is the volume of the sample. K_1 and K_2 are the first and second order anisotropy constants respectively. If K_2 is negligible, expanding equation (1) and substituting $\frac{L}{(MVH)} = \sin(\theta)$, where L is the torque, the following transcendental equation in L will result.

$$L = \frac{2K_1V}{(MVH)^2}\left[\frac{1}{2}\{(MVH)^2-2L^2\}\sin 2\alpha - L\sqrt{(MVH)^2-2L^2}\cos 2\alpha\right]$$