UC13

Development of micro-size search coil magnetometer for magnetic field distribution measurement

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For the magnetic field distribution measurement, MFM and small size Hall probe have been used [1, 2]. In case of MFM use ferromagnetic probe and small size Hall probe use ferrite block to increase sensitivity. Both case we can't measure magnetic field accurately due to the non-linearity and hysteresis properties of ferro- and ferri-magnetic materials.

To overcome these problems, we employed small size of search coil which vibrate in longitudinal direction as shown in Fig. 1. In this case voltage induced from the search coil is

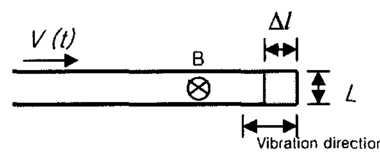

Fig. 1. Schematic diagram of micro-size search coil.

$$V(t) = \Delta l L \omega B \sin \omega t \quad (1)$$

If Δl and L became small, induced voltage $v(t)$ becomes also small, so we must increase vibration frequency ω. For example Δl=0.1 mm, L=0.1 mm and $B(x)=10^{-3}$ T, we need $\omega \sim 10^4$ rad/s to get induced voltage $v(t)$ of 10^{-7} volt. The search coil was constructed with PCB pattern; 100 mm long and 0.2 mm width and high frequency and high power vibrator was constructed using Terfenol-D [3]. To eliminate stray field generated from actuator driving current of frequency f, we used even function λ-H loop. In this case, vibration frequency of actuator is $2f$ and search coil induced voltage is also $2f$ signal, and it is different from driving frequency f. Only this $2f$ signal, we could measure using lock-in amplifier with high s/n ratio. Fig. 2 shows the constructed Terfenol-D actuator with driving frequency of 1 kHz and block diagram of magnetometer is shown Fig. 3. Using the constructed magnetometer, we could measure magnetic field with special resolution of 0.1 mm x 0.2 mm and magnetic field resolution of 1 mT.

The developed magnetometer will be applied to the magnetic filed distribution of magnetic lens in electron-microscope to improve aberration of magnetic lens.

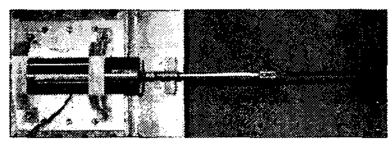

Fig. 2. Photograph of the construction Terfenol-D actuator and micro-size search coil.

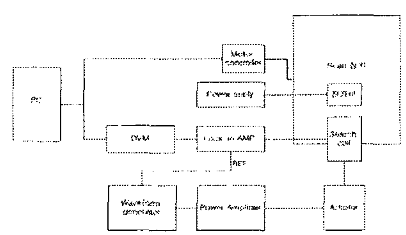

Fig. 3. Schematic diagram of micro-size of search coil magnetometer.

REFERENCES

[1] S. Felton, K. Gunnarsson, P. E. Roy, P. Svedlindh and A. Quist, "MFM imaging of micron-sized permalloy ellipses", Journal of Magnetism and Magnetic Materials,. 280, Issues 2-3,(September 2004), p. 202.

[2] T. Kono, H. Fukai, N. Sakai, S. Nariki, I. Hirabayashi, M. Murakami and N. Koshizuka, " Evaluation of magnetic homogeneities of Gd–Ba–Cu–O bulk superconductors by different Hall probe scanning methods" Physica C: Superconductivity,. 426-431, Part 1,, (October 2005),p. 632.

[3] E. M. Ka, D. Son, "Improvement of resolution for the search coil type magnetic field distribution measuring system" (KMS Press, 2006), p. 212.

UC14

Magnetostrictive micro-actuators fabricated using Fe base amorphous films and micro-patterns

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Amorphous magnetic materials have been attracting great attention in the sensor and actuator research area, because they have extremely large magnetomechanical coupling factors which are originated from both soft magnetic properties and large magnetostriction values. In this study, we have been developing the micro-actuators fabricated using amorphous Fe base films and micro-patterns for the application to a micro-cantilever of atomic force microscope. It is well known that the amorphous alloy shows superelastic property as well as magnetostriction. This means that the robust micro-cantilever could be realized with an amorphous ally film. Moreover the displacement and/or stress in cantilever could be detected by observing the impedance of micro-patterns at the same time with operation. Figure 1 shows the microscope image of the fabricated micro-actuator with 100 μm long which consists of magnetically cross-looped amorphous FeSiB film pattern with 1 μm thick and Au micro-pattern with 0.5 μm thick and 4 turns. The amorphous FeSiB film pattern could vibrate due to magnetostriction of amorphous FeSiB film pattern, which is formed a multilayer structure with SiN film with 1 μm thick when AC current is applied to Au electrodes. To construct an actuator with amorphous magnetic material, we had used a conventional photolithography and anisotropic etching of silicon substrate. In this study, we fabricated the microactuators with 100, 200, 500 μm long using amorphous FeSiB films. Figure 1 shows the microscope image of the fabricated micro-actuator with 100 μm long. Figure 2 shows the External magnetic field dependence of resonance frequency of a-FeSiB cantilever. This result represents the magnetic controllability of the micro-actuator proposed by this study.

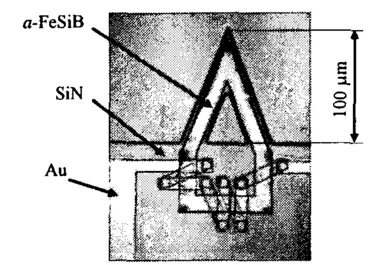

Fig. 1. Micorscope image of the fabricated microactuator with 100 μm long.

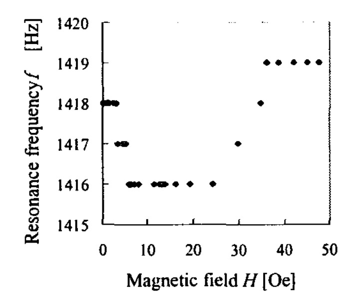

Fig. 2. External magnetic field dependence of resonance frequency of a-FeSiB cantilever.