RESEARCH THE MAGNETIC SENSOR TO DETECT IRON NANOPARTICLE IN HIGH FREQUENCY

NGUYEN THI MINH HAI, NGUYEN HA PHAP, NGUYEN DUC MINH

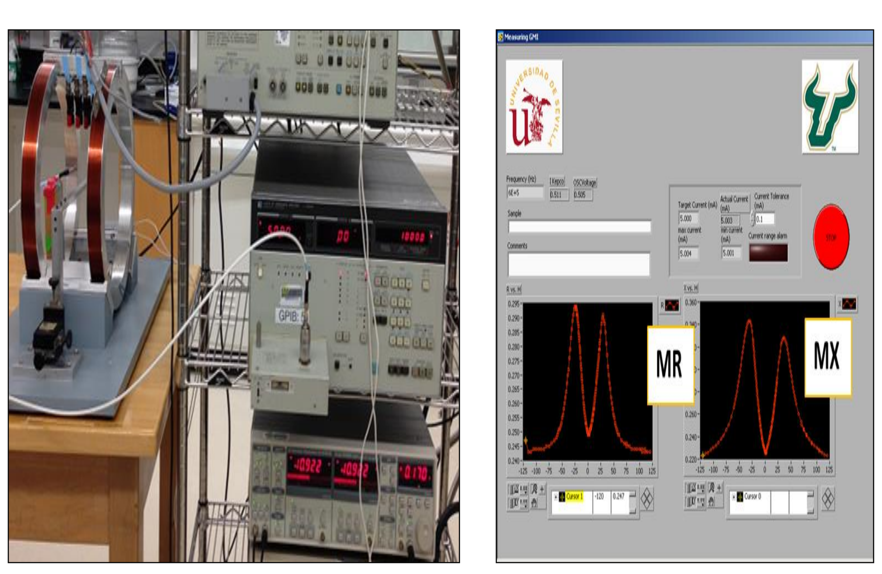
INTRODUCTION

❑ The magetic sensor GMI has high sensitivity, equivalent to that of a SQUID device and operates at room temperature. The nature of GMI effect is a large change in the total impedance Z's value of soft magnetic material when an alternating current is passed, the material is placed in a direct current of external magnetic field (DC) along to the conductor.

❑In this research, we use amorphous magnetic wire CoFeBSi annealed at 350°C as the main component of GMI magnetic sensor in order to discover weak magnetic field that is created by nanoparticle system Fe_3O_4

❑In higher frequency band (f = 100 -1000 MHz), due to the influence of eddy current, the huge reluctance effect will occur strongly on the surface of material.

EXPERIMENTAL



• H = -120 Oe to +120 Oe
• I_{AC} = 5 mA, f = 100-1000 MHz

❑ $Co_{68,2}Fe_{4,3}B_{15}Si_{12,5}$, H_{DC} = 2 Oe . Direct current H_{DC} reaches ± 115 Oe . Nanoparticle system Fe_3O_4 has an average size 10 nm, fabricated by the decomposition method from organic precursor. Plastic racks size 3×2×10 mm³
❑ Fe_3O_4 : m = 10, 20, 30, 40 mg, placed from 1 mm for magnetic wire.

$$\vec{H_o} = \vec{H_{AC}} + \vec{H_{DC}} + \vec{H_g}$$
$$\vec{H} = \vec{H_o} + \vec{H}_{stray}$$

❑ To evaluate the magnetic sensitivity of material, we determine the variation value of R (or ΔR) of magnetic wire sample by measuring R of its wire without ferromagnetic nanoparticle (R_{blank}) and when containing magnetic nanoparticle system Fe_3O_4, which is placed next to magnetic wire ($R_{contain}$). The value of ΔR is determined by the following formula:

$$\Delta R = R_{contain} - R_{blank}$$

❑Kết hợp phương pháp hồi quy tuyến tính cho sự phụ thuộc của R theo từ trường kích thích H_{DC} và sự thay đổi của ΔR theo khối lượng hệ hạt nano Fe_3O_4.

RESULTS AND DISCUSSION

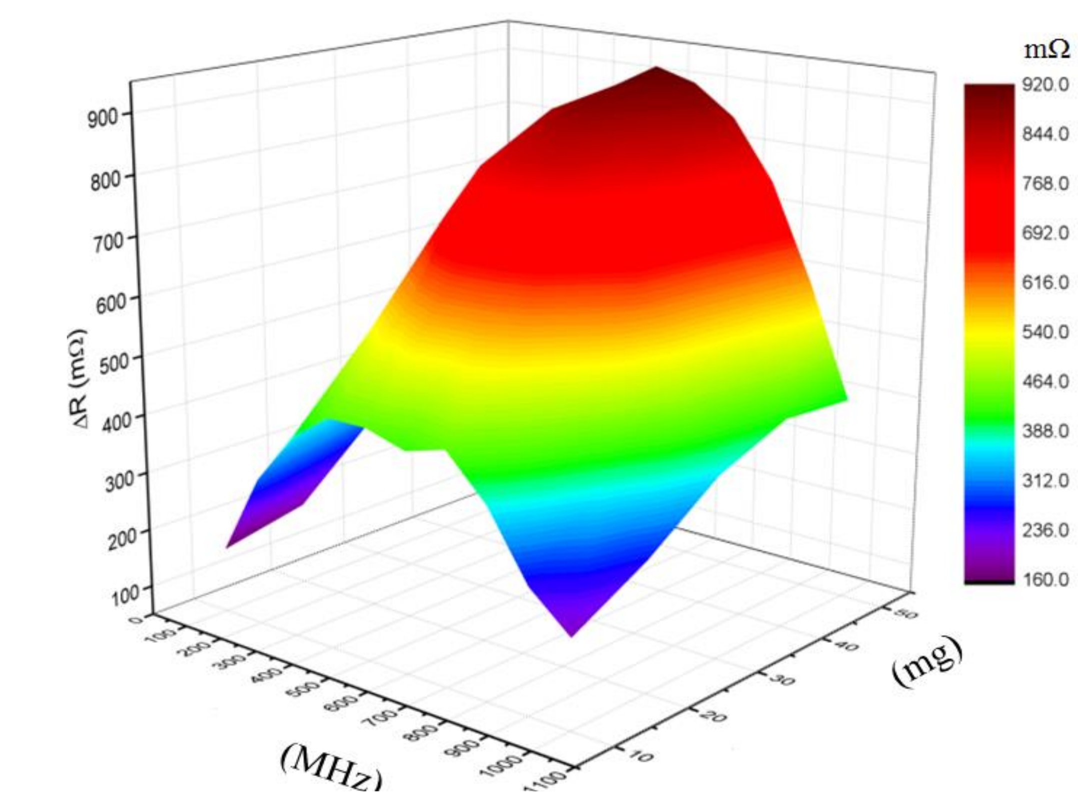


Figure 1: 3D figure describe the dependence of ΔR value of magnetic wire CoFeBSi on frequency and mass of Fe_3O_4 particle

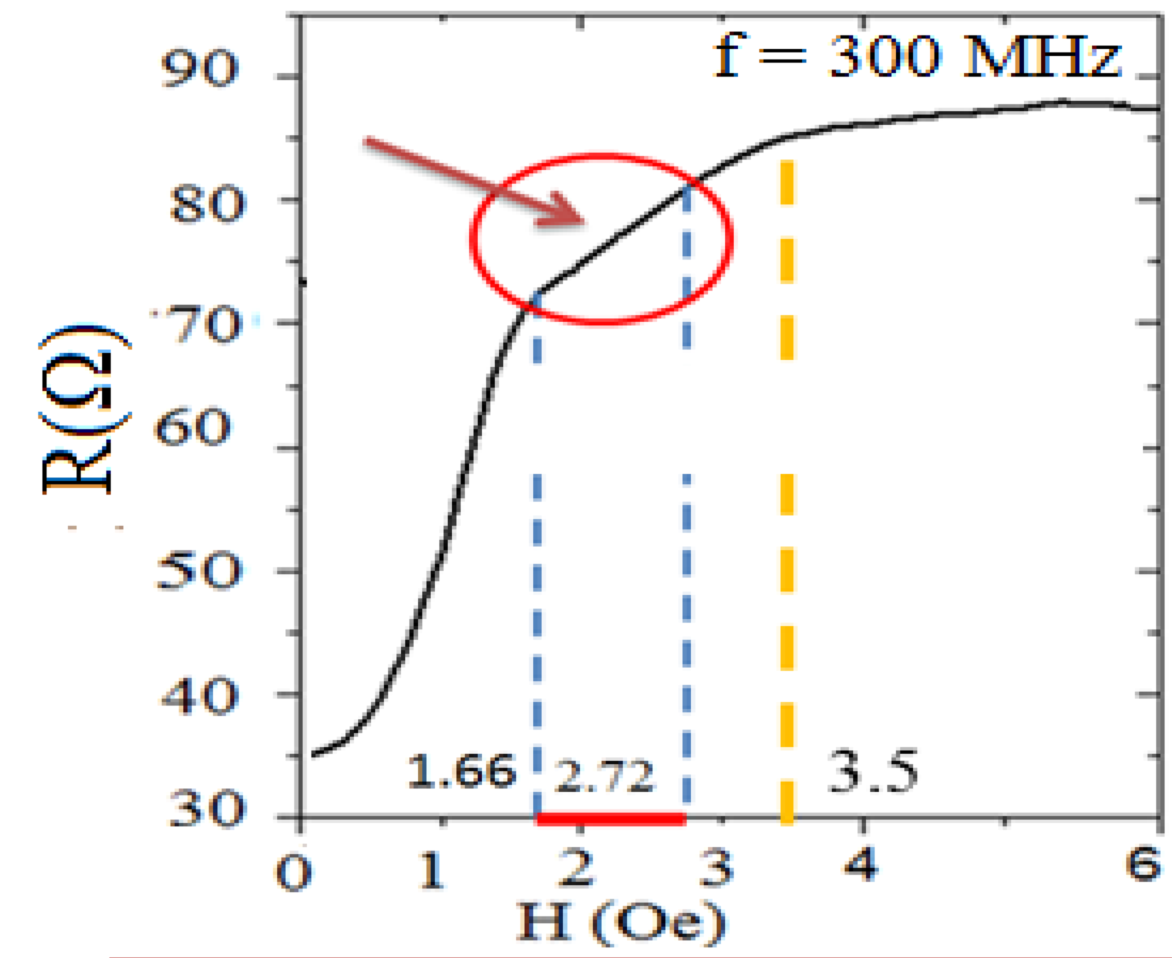


Figure 2: The dependence of R value on the H_{DC} excitation field at frequency f = 300 MHz

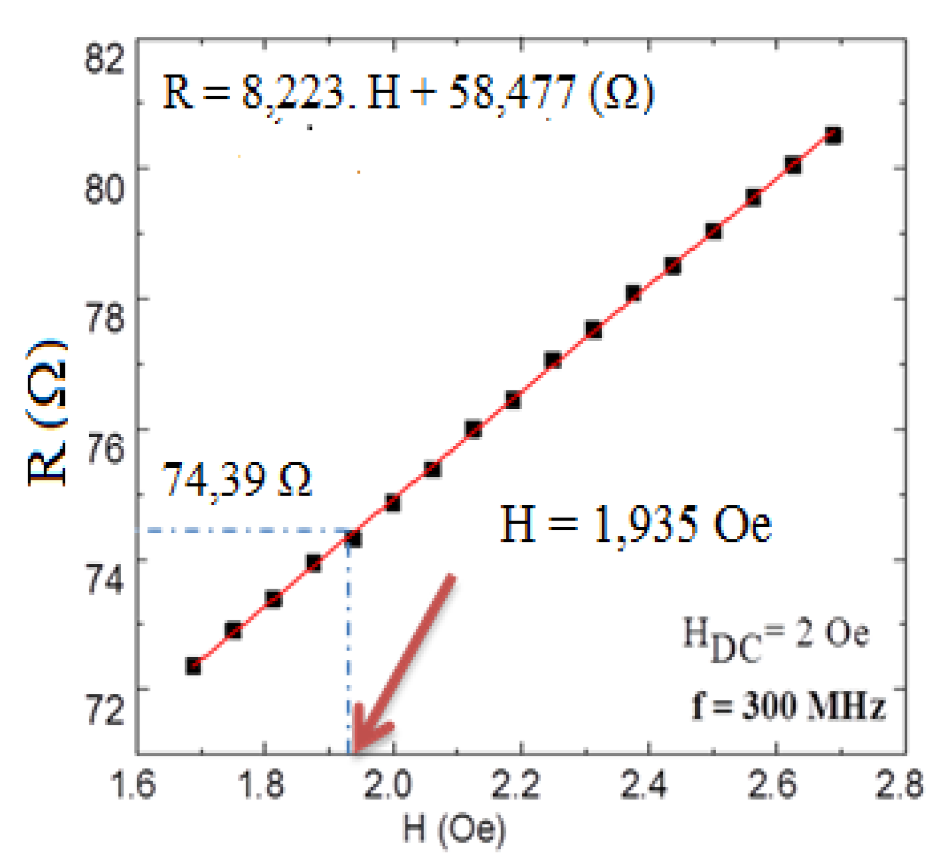


Figure 3: Standard excitation field's dependence of R value of magnetic tape.

m(mg)	$\overline{R}$ (Ω)	$\Delta\overline{R} = \overline{R} - \overline{R_o}$ (Ω)	H(Oe)	$H_{stray} = H - H_o$ (Oe)
0	74,39	0	1,935	0
10	74,545	0,155	1,954	0,019
20	74,613	0,223	1,962	0,027
30	74,703	0,319	1,973	0,038
40	74,784	0,394	1,983	0,048

Table 1. To determine the variation of R value and H_{stray} weak magnetic field value for different Fe_3O_4 nanoparticle masses

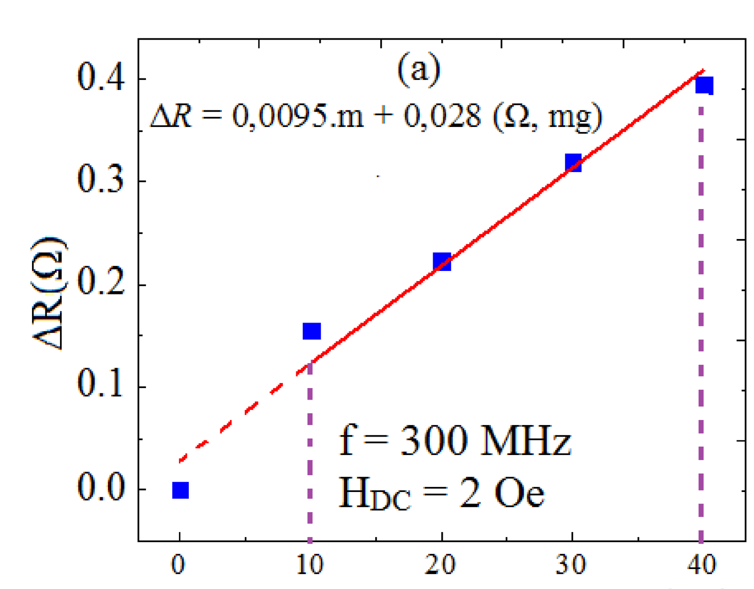


Figure 4: ΔR dependent mass of Fe_3O_4 for amorphous wire.

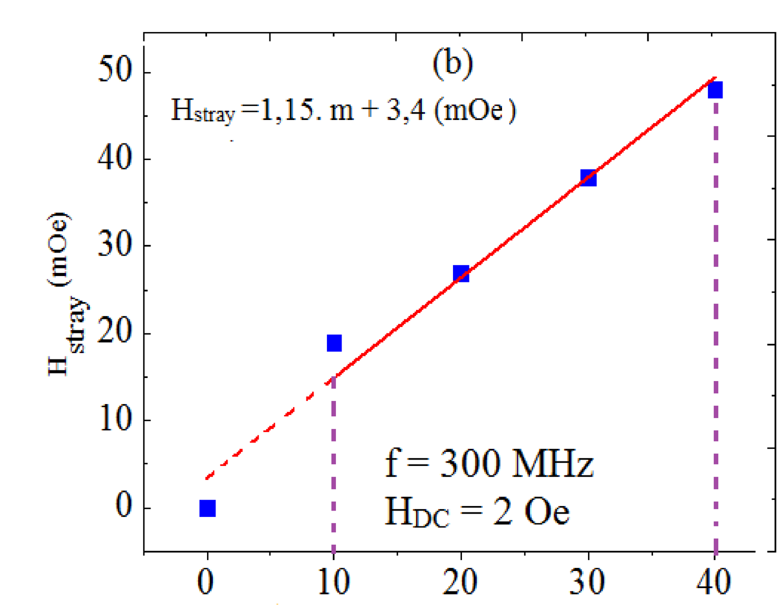


Figure 5: H_{stray} mass of Fe_3O_4 for amorphous wire.

CONCLUSION

We have studied the orientation of the magnetic sensor using an amorphous magnetic wire **CoFeBSi** annealed at **350°C**, in order to detect the weak magnetic field.

This sensor allows to determine the change of **ΔR** according to the mass of **Fe_3O_4** particles. The results show the most stability and clarity when the excitation magnetic field is **2 Oe** and the frequency is **300 MHz**.

The sensor can detect weak magnetic fields in the range of **19-48 mOe** under normal conditions with an accuracy more than 90%