THE FIRST STEP IN STUDYING THE INFLUENCE OF GAMMA RADIATION ON MAGNETIC PROPERTIES OF $CoFe_2O_4$ NANO-PARTICLES

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Abstract:

Our works are aimed at studying the influence of gamma radiation on the nano-size magnetic materials $CoFe_2O_4$.

The ^{60}Co gamma radiation was irradiated on superparamagnetic nanoparticles $CoFe_2O_4$ with various doses.

Superparamagnetic nanoparticles synthesized by coprecipitation method. The magnetic properties is measured by using vibrating sample magnetometer (VSM) after irradiating with doses from 1000 kGy to 2500 kGy. There are the changes of magnetization [M (emu/g)] of $CoFe_2O_4$ nano-particles before and after irradiating.

We particularly note that by similar experiments the influence of gamma radiation on the macro magnetic materials doesn't induce the changes of magnetic properties.

INTRODUCTION

For examining the influence of gamma radiation on superparamagnetic nanoparticles, we performed the study following: the ^{60}Co gamma radiation was irradiated on superparamagnetic $CoFe_2O_4$ nano-particles with doses from 1000 kGy to 2500 kGy. Analysing magnetic properties of this system before and after emitting by hysteresisgraph was showed the change of (B-H) loop is 10%. The magnetic properties is tested by measurements of magnetization curves using vibrating sample magnetometer (VSM) after irradiating with doses 1000 kGy, 1500KGy and 2000 kGy.

Keywords: superparamagnetic, nano-magnetic particles.

EXPERIMENTAL

A mixture of 0.05M $CoCl_2.6H_2O$ 11.9g and 0.1M $FeCl_3.6H_2O$ 27g [Co^{2+}: Fe^{3+} = 1:2] were mixed with 50ml H_2O in 142ml NaOH solution. The chemical reaction of $CoFe_2O_4$ precipitation is expected as follows:

$$2FeCl_3.6H_2O + CoCl_2.6H_2O + 8NaOH \rightarrow CoFe_2O_4 + 8NaCl + 22H_2O$$

Detail experiment is processed as following:

Firstly, $FeCl_3$ and $CoCl_2$ were mixed in distilled water. Next, mixture solution was precipitated with NaOH and stirred by ultrasonic agitation at room temperature. Black precipitate products will be washed by distilled water in magnetic field several times. Finally, products had uniform sphere size about 5-180nm diameter and were dried in vacuum at 70^0C for 48 hours.

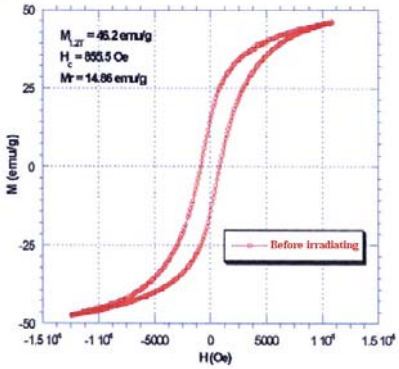
RESULTS AND DISCUSSION

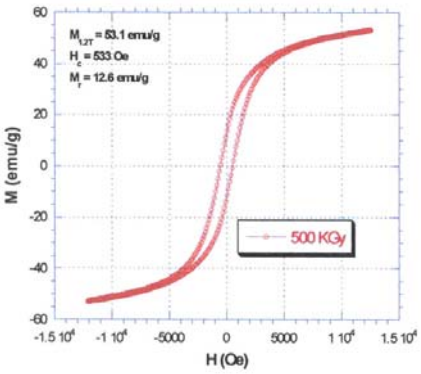
Tables 1 showed results of measurements the coercivity, magnetization and remanent magnetization

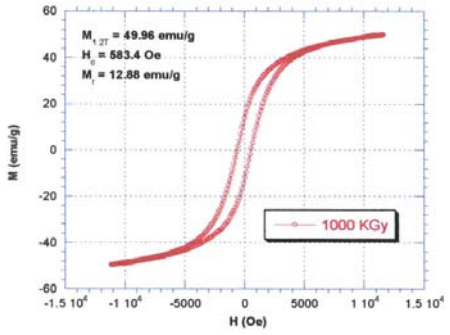
Results	**$M_{1,2T}$** (emu/g)	**H_c** (oe)	**M_r** (emu/g)
Before irradiation	46,2	855,5	14,86
500kGy	53,1	533	12,6
1000kGy	49,96	583,4	12,88
1500kGy	45,6	848,4	12,8
2000kGy	52,6	530,5	12,75
2500kGy	52,6	580	13,6

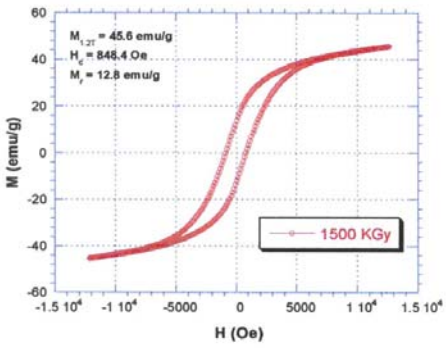
Table 1: Some magnetic properties of $CoFe_2O_4$ nano-particles before and after radiation

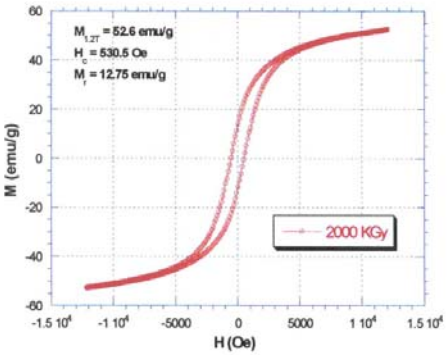
Magnetization curves of 7 samples before and after irradiation

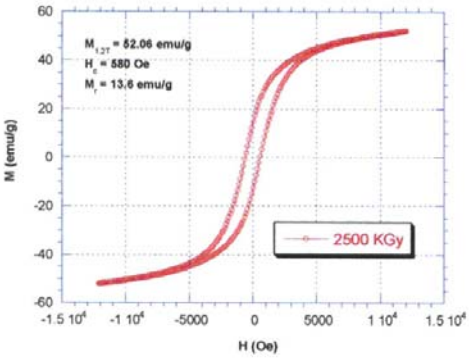




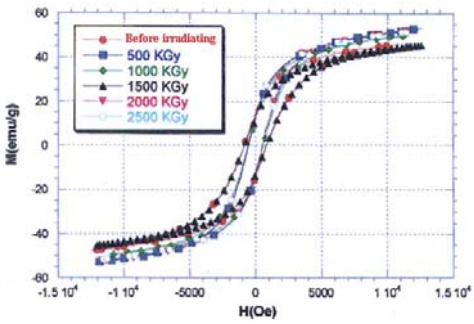








Magnetization curves of 7 samples of $CoFe_2O_4$ after irradiation with doses in 500kGy ÷2500kGy



The remanent magnetization and coercivity nano-particles reduced in after irradiating but the saturation magnetization of nano-particles increased about 46.2 to 53.1 emu/g

M_r reduced from 14.86 emu/g to 12.6 emu/g

H_c reduced from 855.5 Oe to 533 Oe

When gamma radiation emitted on matter, many effects can be appeared in which there is an effect that can change the shell structure and change the spin of atoms constitute materials. So

with the change of the spin, magnetic properties also change. But what effects can change the atom properties? And then why aren't the changes seen if the irradiation was emitted on mass magnetic materials?

We consider that the impactions in both cases of the gamma radiation on magnetic materials induce the changes of magnetic properties. We denote ΔM and M are the change and the tested sample value, respectively. With the mass magnetic materials, M is very large, so the ratio of $\frac{\Delta M}{M}$ can't be observed, but with the nano materials, M is very small and $\frac{\Delta M}{M}$ ratio can be observed very good.

CONCLUSION

- We have made $CoFe_2O_4$ nanoparticles by coprecipitation method
- From testing the radioactivity, we can draw the conclusion that samples do not emit secondary radiation with 2500 kGy dose.
- Analysing magnetic properties of this system before and after irradiating by hysteresisgraph showed the change of (B-H) loop is significant. The result shows the change is approximately 10%. The M_r, H_c nanoparticles reduced after irradiating.

The result will be able to become a new discovery in material science field.

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