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Synthesis, characterization and magnetic properties investigation of Ag-CoFe2O4-GO nanocomposite

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Abstract. In this research, graphene oxide (GO) was first synthesized by modified Hummer method, then Ag-CoFe2O4-GO nanocomposite was prepared using solvothermal route. In addition of GO, the starting materials for preparing the nanocomposite were Co(NO3)2.6H2O, Fe(NO3)3.9H2O and AgNO3.The synthesized sample was characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM) and vibrating sample magnetometer (VSM). No extra peaks, related to impurity phases were detected in the XRD pattern of GO, confirming the complete oxidation of the graphite powder. Also, the XRD pattern of the prepared nanocomposite revealed that the desired structure had been formed. The crystallite size of the prepared sample was estimated and calculated using Scherrer formula and the size-strain plot (SSP) method. The TEM image of Ag-CoFe2O4-GO nanocomposite showed that the surface of GO sheets has been well decorated by Ag and CoFe2O4 nanoparticles with rather good distribution. Magnetic characterization of the Ag-CoFe2O4−GO sample was investigated, at room temperature (300 K), in a magnetic field of 15000 Oe. The hysteresis loop indicated that the value of the magnetic saturation (Ms) of the prepared nanocomposite is 31.9 emu g -1, the remnant magnetization (Mr) 3.7 emu g-1 and the coercive force (Hc) of the sample obtained at 106.8 Oe.

INTRODUCTION

In the past decade, one-dimensional (1D) nanostructured materials, including nanotubes, nanorods and nanowires, have attracted much attention because of their interesting physical properties and a wide range of potential applications in fabricating nano-devices. Nanoparticles exhibit different behavior from the bulk materials, since a significant number of atoms are located at the surfaces or interfaces. In magnetic nanoparticles, this difference in the properties is more obvious, when the size of the grains is reduced to nanoscale, the normal macroscopic domain structure transforms into a single-domain state. Silver nanoparticles have attracted considerable attention and have been used as antibacterial agent for a long time because of the stability, durable and broad spectrum antibacterial activity. Among the metallic nanoparticles such as: copper, zinc, titanium and gold, silver nanoparticles have higher antibacterial efficacy. Recent studies have revealed that silver nanoparticles have superior antibacterial activity compared to that

of other silver compounds as well as bulk silver. In addition, nanosilver has a broad-spectrum antibacterial activity to kill a variety of bacteria existing in everyday life including those that are antibiotic resistant.

Graphene, a monolayer or few layers two-dimensional planar sheets composed by sp2-bonded carbon atoms, has attracted great attention due to its excellent physical and chemical properties. The unique and fascinating properties make graphene to be used in catalysts, batteries, sensors, electromagnetic interference (EMI) and supercapacitors. [1,2]

EXPERIMENTAL SECTION

Graphene oxide was first synthesized by a modified Hummer method. Then, Ag-CoFe2O4-GO nanocomposite was prepared by the solvothermal route. The starting materials used for the synthesis Ag-CoFe2O4-GO nanocomposite were $Co(NO3)_2$ .6H2O, $Fe(NO3)_3$.9H2O, $AgNO_3$ and ethanol as the solvent. First, $Co(NO3)_2$ .6H2O, $Fe(NO3)_3$.9H2O, $AgNO_3$ were dissolved in 20 mL of ethanol, while stirring at room temperature. The prepared solution was gradually added into the GO suspension and stirred for 30 min. the mixed solution was then transferred into a Teflon-line autoclave and heated in an oven at 200 ºC for 18 h. The obtained black product was washed several times using distilled water and ethanol. Finally, it was dried in an oven at 60 ºC for 18 h. [3,4]

RESULTS AND DISCUSSION

The XRD pattern of the Ag-CoFe2O4-GO nanocomposite is given in Fig. 1 . As the pattern shows, the desired phase with no additional peaks has been formed. The crystallite size of the prepared composite was estimated using Scherrer formula, accordingly:

$$D = {k\lambda}/{\beta \cos\theta}$$

where D is the crystallite size (nm), λ is the X ray wavelength (1.54056 Å for CuKα radiation), k is a constant equal to 0.94, β is the peak width at the half-maximum intensity, and θ is the peak position.

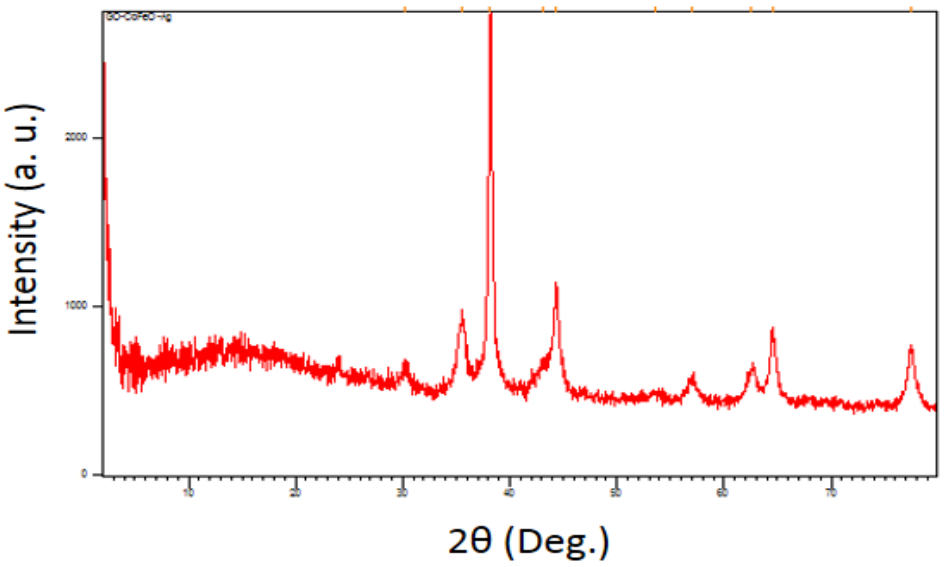

Figure 1. XRD pattern of the synthesized Ag-CoFe2O4-GO composite

The TEM image of the synthesized nanocomposite is shown in Fig 2.This figure shows that nano CoFe2O4 and silver particles have been anchored, with rather good distribution, on GO sheet with particle size in the range of 10-20 nm and 40-50 nm, respectively. The presence of GO could stabilize nanoparticles on it and prevents them from aggregation.

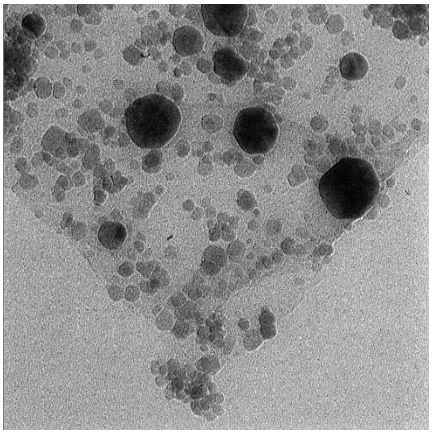

Figure 2. TEM image of Ag-CoFe2O4-GO nanocomposite

Figure 3. indicates the hysteresis loop of Ag-CoFe2O4-GO nanocomposite obtain by VSM technique. Magnetic characterization of the Ag-CoFe2O4−GO sample was investigated, at room temperature (300 K), in a magnetic field of 15000 Oe. The hysteresis loop revealed that the value of the magnetic saturation (Ms) of the prepared nanocomposite is 31.9 emu g^{-1}, the remnant magnetization (Mr) 3.7 emu g-1 and the coercive force (Hc) of the sample was obtained 106.8 Oe. Ag-CoFe2O4-GO nanocomposites could be easily separated from solution with an external magnetic force.

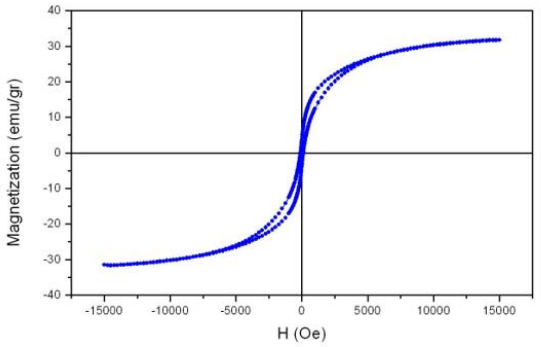

Figure 3. The hysteresis loop of the prepared Ag-CoFe2O4-GO nanocomposite

CONCLUSION

In this paper, Ag-CoFe2O4-graphene oxide (Ag-CoFe2O4-GO) nanocomposite was synthesized by solvothermal method. The Ag-CoFe2O4-GO nanomaterial was characterized by XRD spectroscopy, TEM and VSM techniques. The XRD pattern of the prepared nanocomposite revealed that the desired structure had been formed**.** The TEM image

of Ag-CoFe2O4-GO nanocomposite showed that the surface of GO sheets has been well decorated by CoFe2O4 and also Ag nanoparticles, almost uniformly, with the particle size in the range of 10-20 nm and 40-50 nm, respectively.

REFERENCES

[1] Kooti, M., S. Saiahi, and H. Motamedi. "Fabrication of silver-coated cobalt ferrite nanocomposite and the study of its antibacterial activity." *Journal of Magnetism and Magnetic Materials* 333 (2013): 138-143.
[2] Gao, Nan, Yingjie Chen, and Jiang Jiang. "Ag@ Fe2O3-GO nanocomposites prepared by a phase transfer method with long-term antibacterial property." *ACS applied materials & interfaces* 5, no. 21 (2013): 11307-11314.
[3] Ma, Shuanglong, Sihui Zhan, Yanan Jia, and Qixing Zhou. "Highly efficient antibacterial and Pb (II) removal effects of Ag-CoFe2O4-GO nanocomposite." *ACS applied materials & interfaces* 7, no. 19 (2015): 10576-10586.
[4] Sharma, S. K., G. Lopes, J. M. Vargas, L. M. Socolovsky, K. R. Pirota, and M. Knobel. "Synthesis of Ag–CoFe2O4 dimer colloidal nanoparticles and enhancement of their magnetic response." *Journal of Applied Physics* 109, no. 7 (2011): 07B530.
[5] Xu, Yuanguo, Teng Zhou, Shuquan Huang, Meng Xie, Hongping Li, Hui Xu, Jiexiang Xia, and Huaming Li. "Preparation of magnetic Ag/AgCl/CoFe 2 O 4 composites with high photocatalytic and antibacterial ability." *RSC Advances*5, no. 52 (2015): 41475-41483.