

DOUBLE SHELL FeNi NANOPARTICLES

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INTRODUCTION

Nanoscale materials and magnetic nanoparticles particularly, have attracted significant scientific and industrial interest due to unique properties compared with bulk materials. Due to large coercivity, remanence, and time stability at room temperature, magnetic nanoparticles have been considered especially attractive for applications in magnetic recording density, recording speed, noise suppression and sensors.

Thermal decomposition, sonochemical method, laser pyrolysis and reduction of salts with borohydride derivatives are some synthetic techniques used to synthesize magnetic metal nanoparticles.

Last years, these nanoparticles embedded in a polymeric matrix were used to obtain new material with potential applications as microwave absorbing and shielding also and in electromagnetic devices. In order to obtain this kind of devices and improve dispersion of nanoparticles inside organic matrix a new type of nanoparticles has been synthesized. In the present work, synthesis of FeNi alloy nanoparticles by reducing iron and nickel salts with borohydride derivatives and their surface modification are shown.

METHODS

Synthesis of FeNi nanoparticles by reduction of salts with borohydride derivatives presents several advantages such as synthesis at room temperature and one step reaction.

Several authors demonstrated that sol-gel process could be directly applied to coat iron oxide nanoparticles or silver nanowires with well-controlled silica shells. This technique that is praised as a route for the fabrication of novel materials with a tremendous potential application, was used to generate the first SiO₂ shell on FeNi nanoparticles.

A second organic shell was grown on surface of nanoparticles by atomic transfer radical polymerization.

Techniques such as Fourier Transform Infrared (FTIR) spectroscopy, thermogravimetric analysis (TGA) and atomic force microscopy (AFM), Inductively Coupled Plasma (ICP) were used to characterize the functionalized particles.

RESULTS AND DISCUSSION

FeNi nanoparticles were synthesized by reducing iron and nickel salts with borohydride derivatives and characterized.

Afterwards, FeNi nanoparticles were covered by SiO₂ shell by sol-gel process. As Figure 1 shows, two new peaks were observed in the FeNi nanoparticles covered by SiO₂ shell (FeNi-SiO₂). One of them was attributed to asymmetric stretch vibration of Si-O-Si (1080 cm⁻¹) and second one is attributed to symmetric stretch vibration of Si-O-Si (800 cm⁻¹). FTIR analysis allows to confirm that FeNi nanoparticles were covered by SiO₂ shell.

Surface of FeNi-SiO₂ was modified with an initiator (2-(4-chlorosulfonylphenyl)ethyl trichlorosilane) (FeNi-CTCS) that allows the initiation of ATRP polymerization.

The modification of FeNi-CTCS with PS (FeNi-PS) was confirmed by FTIR, where an increase of the characteristic stretching bands of aromatic chains over 3000 cm⁻¹ is observed in FeNi-PS, furthermore, three new peaks at 1600, 1500, and 1450 cm⁻¹, attributable to characteristic bands of PS, can be seen.

CONCLUSIONS

A double shell was grown onto surface of synthesized FeNi nanoparticles powders using sol-gel to generate SiO₂ shell and “graft from” technique to grown Ps brushes by ATRP. Composition of FeNi alloy nanoparticles was determinate by ICP. Modified and unmodified FeNi nanoparticles were characterized using FTIR, confirming that a double shell was covered FeNi nanoparticles. TGA allowed to analyze the difference of organic material between FeNi, FeNi-SiO₂, FeNi-CTCS and FeNi-PS.

ACKNOWLEDGMENTS

The present work was supported by Ministerio de Educación y Ciencia (project MAT2007-66798-C03-03).

REFERENCES

- [1] M. Zulfikar, A. W. Mohammada, A. Amir Kadhum, N. Hilal, *Materials Science and Engineering A* 452–453 (2007) 422.
- [2] G. Ennas, A. Musinu, G. Piccaluga, D. Zedda, D. Gatteschi, C. Sangregorio, J. L. Stanger, G. Concas, G. Spano, *Chem. Mater.* 10 (1998) 495.
- [3] H. Schmidt *Appl. Organometal. Chem.* 15 (2001) 331.
- [4] E. Marutani, S. Yamamoto, T. Ninjbadgar, Y. Tsujii, T. Fukuda, M. Takano *Polymer* 45 (2004) 2231.
- [5] Y. Tee, E. Grulke, D. Bhattacharyya *Ind. Eng. Chem. Res* 44 (2005) 7062.

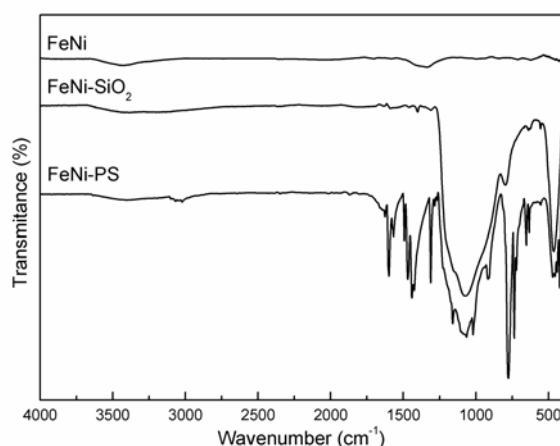


Figure 1. FTIR spectra of FeNi, FeNi-SiO₂ and FeNi-PS spectra.