Magnetite synthesis by calcination of sucrose

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Introduction

Real benefits of nanotechnology both in industrial processes and in medicine are being inimitable. The way nanoparticles are synthesized may determine their morphological uniformity, their particle sizes distribution and, as a critical feature for clinical purposes, their purity. In this work magnetite nanoparticles were synthesized by reducing the chemical oxidation state of iron in a commercial synthetic maghemite. The direct solid-state chemical conversion procedure that was first used by Pereira[1] to obtain magnetite by mixing and burning a natural hematite (γFe_2O_3) with glucose was found unsuccessful, in the present case. Instead, the magnetite could only be effectively produced by putting the reacting mixture of the starting synthetic commercial maghemite (Sigma-Aldrich # 544884-25) mixed with sucrose in two inversely coupled crucibles in a furnace at 400 °C for 20 min.

Results and Discussion

The samples were characterized by Mössbauer spectroscopy, XRD, and FTIR. The 298 K-Mössbauer spectrum collected for the starting commercial maghemite, as received, and the corresponding parameters are given in Figure 1 and Table 1. Figure 2 shows the spectrum and the corresponding parameters (Table 2) for the obtained magnetite by using a mass ratio maghemite:sucrose of 1:5.

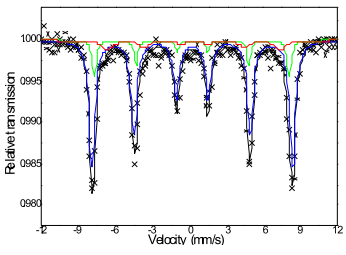

Figure 1. 298 K-Mössbauer spectrum for the starting commercial synthetic maghemite.

Table 1: Hyperfine parameters of the fitted Mössbauer spectra recorded at 298 K.

δ*/mms^{-1}	2ε/mms^{-1}	B_{hf}/T	RA/%
0.33	0.01	50.3	77
0.30	-0.06	48.8	13

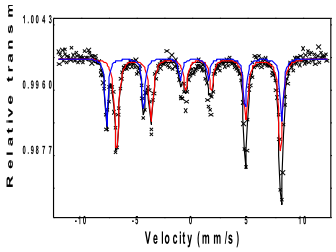

Figure 2. 298 K-Mössbauer spectra for the obtained magnetite after the calcinations of maghemite with sucrose.

Table 2: Hyperfine parameters of the fitted Mössbauer spectra recorded at 298 K.

δ*/mms^{-1}	2ε/mms^{-1}	B_{hf}/T	RA/%
0.65	0.04	45.9	64
0.27	-0.02	48.9	34

*Relative to αFe.

Conclusions

This newly adapted method to obtain uniformly-sized, clean material of pure magnetite, through solid state chemical reduction of hematite of known sizes distribution, confirms its real perspectives on the production of magnetic nanoparticles that can be suitably used in medical practices, as in magnetically-assisted therapies, in oncology, for being nearly non-toxic to humans and for their

effective hyperthermic response.

Acknowledgments

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(Pereira, MC (2009) Preparação de novos catalisadores tipo Fenton heterogeneous à base de óxidos de ferro formados em litologia de itabirito. DSc thesis. UFMG, Brazil. In Portuguese.