Development and Preparation of Nanoscale Iron Particles

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Abstract
Nanoscale iron particles are expected to have practical uses in many engineering fields and there are several potential methods of preparing of nanoscale iron particles. Some of the methods currently used are chemical reduction, sol-gel method, and thermal decomposition. These methods are critically reviewed.

1.� INTRODUCTION

Nanoparticles display novel physical properties due to (1) finite-size, and (2) surface/interface effects. Every known materials will yield a new set of properties, dependent on the size, such as optical properties, magnetic properties, catalyst and crystal morphologies. In recent years, studies in the ultra-fine iron particles are expected to have uses in the field of powder metallurgy, magnetic recording, ferrofluids, and water treatment. Some common chemical methods of preparation of nanoscale iron particles are viewed next.

2. OBJECTIVES

Evaluating methods to produce nanoscale iron. Specific objectives are (1) Review methods of producing nano iron; (2) Verify methods to produce nano iron.

�REVIEW OF LITERATURES

(a) Chemical Reduction method

Nanoscale iron can been prepared by the reaction of Fe(III) chloride, and sodium borohydride in aqueous solution[1]. X-ray diffraction, Mossbauer spectroscopy and elemental analyses can be used to confirm the compositions and structure of the product. The reaction can be reprented as:

$$Fe(H_2O)_6^{3+} + 3BH_4^- + 3H_2O \rightarrow Fe(s) + 5H_2 + 3B(OH)_3$$

This approach can also be used to fabricate nanocrystalline Fe-Cu alloy, and Fe-P-B ultrafine amorphous particles. In addition, it does not require extensive processing equipment and the cost of production can be relatively low compared with other methods.

(b) Sol-gel Method

Glass-metal nanocomposites incorporating ultra-fine particles of iron can be prepared by heat treatment of a gel derived from a sol containing silicon tetraethoxide and a metal compound, such as $Fe(Cl)_3$.� In the process, spherical-shaped metal particles are isolated and with diameters ranging from 3-10 nm. The optical absorption and electrical conductance of such films have been measured. The resistivity values in the range 0.0001-0.0039 Ωcm have been obtained depending on the particle diameter. The rate of resistivity change increased as the metal particle diameter becomes smaller.

(c) Thermal Decomposition

In this method, iron pentacarbonyl can be thermally decomposed in an organic liquid. The mixture is refluxed and stirred for 5-6h initially at 390K rising to 460 K as the reaction proceeded. Mossbauer-spectroscopy and X-ray-diffraction studies show that the sample contains small particles of a metallic glass. Annealing the particles at 523K results in crystallization of the particles into a mixture of α-Fe and χ �Fe_5C_2, of 8.5 median diameters. This method of carbonyl decomposition has been used to prepare small particles suitable for use in ferrofluids.

�PRELIMINARY RESULTS

The chemical reduction method for preparing nano iron was selected for experimental verification. $Fe(Cl)_3$ and $NaBH_4$ solution are being used.

5. CONCLUSIONS

1) Chemical preparation of nanoscale particles permits the manipulation of matter at the molecular level and has good chemical homogeneity; the role of such method has been rapidly growing.
2) Chemical preparation of nanoparticles of iron is of great interest because of its merits, such as low cost, better control of particle size and size distribution.

6.� ACKNOWLEDGEMENT

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7.� REFERENCES

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