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Temperature influence on the properties of carbon-encapsulated iron nanoparticles forming in pyrolysis of gaseous precursors

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Abstract

In the present study the carbon-encapsulated iron nanoparticles were synthesized by shock waves pyrolysis of the $Fe(CO)_5$ vapor in the mixture with C_2H_2 or C_6H_6 diluted by argon. The iron nanoparticles were formed behind incident shock waves at the temperatures of 600-1200 K. The pyrolysis of hydrocarbons behind the reflected shock waves at the temperatures of 1100-2500 K resulted in carbon shell formation over iron nanoparticles. The mean particle sizes measured by transmission electron microscopy were found to be 3.5-5 nm and 7-10 nm for the samples formed in the mixtures with presence of acetylene and benzene correspondingly. The extinction measurements of condensed phase growth and laser-induced incandescence measurements of particle sizes were used as *in-situ* diagnostics. The dependences of particle volume fraction and final particle size on temperature of pyrolysis and kind of hydrocarbon are presented and discussed.

Keywords: nanostructured materials, transition metal alloys and compounds, gas-solid reactions, optical properties, catalysis, optical spectroscopy, transmission electron microscopy TEM, X-ray diffraction

1. Introduction

High purity iron and iron oxide nanoparticles are used in diagnostics of cancer tumors [1] and also promise the essential therapeutic effect in treatment of cancer [2]. Carbon shell over metal nanoparticles results in their much higher stability in various chemical and physical environments. The carbon not only protects the nanoparticles from oxidation, but also opens the possibility of optimizing their intrinsic magnetic properties [3]. Additionally, metal-carbon nanoparticles can be used in the preparation of new materials for electronics: magnetic sensors, magnetic storage media, electronic and optoelectronic devices [4]. Thus, the development of carbon-encapsulated iron nanoparticles (CEINs) synthesis methods is important from a practical and theoretical point of view. A number of different methodologies have been developed for the

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