

Microstructure and Surface Characterization of Fe Nanocapsules synthesized by PAD Process

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1. Introduction

Nanocapsules have recently become one of the most active research fields in the areas of solid state physics, chemistry and materials science, and have a great potential in the industrial areas, because of their novel properties such as electrical, magnetic, chemical and optical properties. Especially, the metallic iron nanocapsules have been stimulated by the interest for their technological applications, such as magnetic tapes, ferrofluid, magnetic refrigerants.

In this paper, we focused on synthesis of Fe nanocapsules using Plasma arc discharge method under the mixture of (Ar+H₂+CH₄)

2. Experimental Procedure

Fe nanocapsules were synthesized under the different ratio of CH₄ contents (2.5~20 vol%) in reactive gases. Pure Fe rod (99.9%, Japan), Carbon rod was used as an anode and cathode respectively. Argon gas, methane gas and hydrogen gas were introduced as an reactive gas at the controlled pressure(300 Torr) after chambers were evacuated to 3×10⁻¹ Pa. The synthesized Fe nanocapsules were investigated by means of XRD, HRTEM, XPS and Mossbauer analysis.

3. Results and discussion

Fe nanocapsules were successfully synthesized by plasma arc discharge process in the various methane gas. The microstructure and surface properties of Fe nanocapsules were strongly affected by methane gas and hydrogen gas. Hydrogen gas played an important role on the formation of Fe metallic vapors. The activated hydrogen atoms in plasma arc are dissolved into the molten iron at the central part of its surface where the temperature is the highest the dissolved hydrogen atoms are diffused into the molten iron at the part of its surface where the temperature is the lowest. The dissolved hydrogen atoms with metallic Fe vapors are released from the peripheral region and recombined into molecular hydrogen at the part of its surface where the temperature is lowest. These vapors disperse in the cycling atmosphere of Ar and H₂ and than the vapors atoms condense to form droplets or nuclei. α-Fe, γ-Fe and Fe₃C particles were synthesized by the reaction between metallic vapors and dissociated carbon atoms. The surface of nanocapsules was mainly composed of carbon and a little amount of C-O, Fe₃C. The prepared Fe nanocapsules were consisted of metallic Fe, Fe₃C core and carbon shell structures with nearly spherical shapes(<20 nm).

Acknowledgments

This research was supported by a grant from the Center for Nanostructured Materials Technology(CNMT) of the 21st Century Frontier Program funded by the Ministry of Science and Technology, Republic of Korea