



Morphology and Phase Evolution in Microwave Synthesized Al/Fe₃O₄ System

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Received: May 25, 2011

Accepted: August 29, 2011

ABSTRACT

Thermite reaction between Al/Fe₃O₄ raised by microwave (MW) heating under N₂ atmosphere has been investigated, and compared with that by the electric furnace. In addition to the stoichiometric ratio for the production of metallic iron and alumina, mixture with slightly lower in Al content is also studied. As thermite reaction is highly exothermic, melting of reaction product and destruction of microstructure may occur, which corresponds to the enthalpy and adiabatic temperature of the reaction. Hence, to avoid this problem, reaction coupled with a smaller driving force by controlling the MW ignition condition at low temperature exotherm has been investigated. The phase and microstructure evolution during the reaction were analyzed by differential thermal analysis (DTA), X-ray diffraction (XRD), and scanning electron microscopy (SEM). Thermogram of the DTA analysis, irrespective of their mole ratio, recorded two exothermic peaks, one at ~ 1310°C and another one at ~ 1370°C. When heated by microwave at 955°C, the main products were identified as Al, FeO and Fe, minor amount of Fe₃O₄ and some Fe and alumina were detected. When heating to 1155°C, Al and Fe₃O₄ peaks disappeared, formation of Fe-Al alloy was observed. For sample heated at 1265°C, a porous body was obtained. Micron sized metal particles with complex morphology, irregular in size and shapes were formed, uniformly distributed within the spinel hercynite and/or alumina matrix. In contrast, conventional heating produced no porous products. Formation of alumina is also observed around the metal particles. Controlling of the reaction progress was possible while heating the sample by MW around the low temperature exotherm region, whereas the combustion wave could not be self-propagated.

KEYWORDS: microwave synthesis; Al:Fe₃O₄; exothermic; substitutional reaction

INTRODUCTION

The self-propagating high temperature exothermic reactions are suitable heat source to several engineering application; such as welding of railway track, cutting and perforation of materials, an additive to propellants and explosives, treatment and recycling of zinc