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Morphology and phase evolution in microwave synthesized Al/Fe 3O 4 system

Abstract

Thermite reaction between Al/Fe 3O 4raised 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 Fe 3O 4and some Fe and alumina were detected. When heating to 1155°C, Al and Fe 3O 4peaks 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

Al:Fe 3O 4; Exothermic; Microwave synthesis; Substitutional reaction