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Short Communication

Hydrothermal synthesis of monoclinic - cubic Li_2TiO_3 hybrid nanocomposite microspheres

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ABSTRACT

Li_2TiO_3 compound is one of the most important tritium breeding ceramics for industrial application in the nuclear fusion reactor. The use of the hydrothermal method for preparing ceramic composite materials is new trend. In this work, hybrid nanocomposite microspheres of the nanocrystallites Li_2TiO_3 were prepared at low temperature 400°C. Nanocomposite powders synthesized by the batch supercritical hydrothermal method for 12 hours under pressure 12MPa. The raw materials were used containing tetrabutyl titanate ($Ti(C_4H_9O)_4$) as a titanium source, lithium nitrate ($LiNO_3$) as a lithium source, citric acid as a chelating agent and nitric acid as pH controller. The samples were characterized by scanning electron microscopy (SEM) and transmission electron microscopy (TEM) and X-ray diffraction (XRD). The SEM micrographs

showed the synthesized powders have microsphere shape with range size 1 to 3.5 micrometers. XRD result illustrates the microspheres are nanostructure with cubic and monoclinic crystal structures. According to XRD results and using known Scherrer's equation, the crystallite size of monoclinic phase about 18 nm and monoclinic about 14 nm were determined. The TEM results show that two type of particles morphologies are present in the synthesized microspheres. The first is a spherical shape with a particle size smaller than 100 nm and second is an irregular shape with a particle size between 100 to 200 nm.

Keywords: Li_2TiO_3; tritium breeding; microspheres; lithium-ion; hydrothermal synthesis

Introduction

The blanket of fusion reactor is a vital component for this type of reactor due to it directly involves tritium breeding and energy extraction, in which way are acute to production of electricity [1-3]. In the progress of tritium breeding ceramics, the Li_2TiO_3 is accepted as the prominent material due to its reasonable low activation, suitable chemical stability characteristic, high lithium atom density, good compatibility with reactor elements, admissible mechanical property and extremely tritium release characteristics [4, 5]. Electrode materials for lithium-ion batteries [6, 7], cathode for molten carbonate fuel cells [8], CO_2 absorber [9, 10], catalyst [11] and phosphor material [12] are other applications for Li_2TiO_3.

There are various methods such as direct thermal decomposition [13] sol-gel [14] ultrasonic irradiation [15] and combustion [16] synthesis for the preparation of composite powders. However, the hydrothermal method provides supreme feasibility for the processing of advanced materials. Also, the hydrothermal synthesis technique has gained significance because of their low energy requirement as green chemistry methods [17, 18]. Chemical processes such as hydrothermal method usually produce better homogenization of the particles at the molecular and atomic levels which produce better properties such as submicron sized particles [18, 19]. The reports have described the preparation of Li_2TiO_3 by the hydrothermal technique are scarce [20, 21]. Yu and co-worker [22] synthesized pure phase Li_2TiO_3 nano-particles via hydrothermal reaction using anatase TiO_2 and $LiOH{\bullet}H_2O$ at 200°C. Abbasian and co-worker [17] synthesized the nanocrystallites Li_2TiO_3 powders with cubic and hexagonal hybrid crystal phases at 200°C and 12h period using the hydrothermal method. Present work reports the synthesis of the Li_2TiO_3