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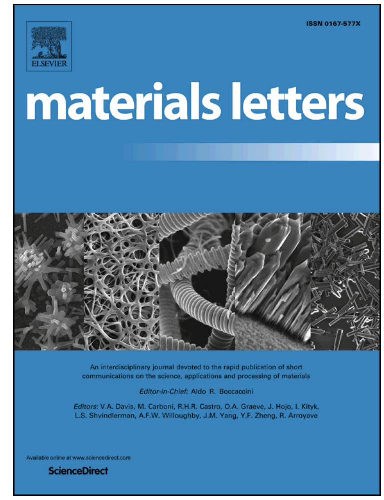

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Ultrafast synthesis of crystalline Cu_2ZnSnS_4 nanoparticles by solid state microwave heating technique and study of their electrochemical behavior

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Abstract

A facile, rapid one-pot microwave heating technique in solid state is introduced to prepare crystalline Cu_2ZnSnS_4 (CZTS) nanoparticles without any post-reaction. The microwave irradiation was operated with a power of 900 W for 20 min. Structure and morphology of the product were characterized using XRD, Raman, SEM, EDS, TEM and SAED analyses. The XRD, Raman and EDS analyses showed the formation of a pure kesterite phase of CZTS. SEM and TEM images revealed uniform particulate morphology with an average particle size of 38 nm and a single-phased crystalline SAED pattern. The electrochemical measurements of the as-synthesized product revealed a good nature of energy storage with a specific capacitance of 185 F g^{-1} at 5 mVs^{-1}. Such multi-components materials can offer as an inexpensive and nontoxic candidate for mass production of supercapacitor and energy storage systems.

Keywords: Nanoparticles, Powder technology; Multilayer structure; Semiconductors; Chalcogenide; Microwave.

1. Introduction

In recent years, many studies has been carried out to synthesize various semiconducting nanomaterials with high capacity as alternative energy storage systems compared with traditional ones. In fact, the worldwide increase of energy demand and also the concerns about increasing environmental contaminations cause to develop many researches in the production of effective and low-cost materials for application in supercapacitors, photovoltaic devices and solar cells [1]. It has been believed that multi-components chalcogenids can be benefited in the design of supercapacitor electrodes due to their high electrochemical capacitance and high power conversion efficiency. Quaternary metal chalcogenides form a wide range of solid solution systems assembling of different metals with at least one chalcogen element i.e., sulfide, selenide and telluride [2]. Due to special physical and chemical properties, they represent a highly potential for applications in electronic, optic, solar energy conversion, solar absorbers, catalysis, etc [3, 4]. Copper-zinc-tin-sulfide (Cu_2ZnSnS_4, CZTS) as a promising alternative material belonging to the