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The Optical and Structural Properties of the Synthesised Cu Nanostructure using Hydrothermal Microwave-Assisted Method

Puhanes Murthy [a], Nurul Akmal Che Lah [a,b,c,*]

[a] Faculty of Manufacturing and Mechatronics Engineering Technology, Universiti Malaysia Pahang, 26300 Pekan, Pahang, Malaysia
[b] Center for Advanced Intelligent Materials, Universiti Malaysia Pahang, 26300 Gambang, Pahang, Malaysia
[c] Centre of Excellence for Advanced Research in Fluid Flow (CARiFF), Universiti Malaysia Pahang, 26300 Gambang, Pahang, Malaysia

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ABSTRACT

Copper (Cu) nanostructure is a potential cost-saving conductive material that might be used in the development of nano-electronic devices. However, the development of Cu nanostructure as an alternative source for silver or gold is hampered not only by its stability in atmospheric surroundings in the nanometer range but also by the lack of a straightforward synthetic approach to create them in excellent yield as well as enhance their optical and structural properties. Therefore, a hydrothermal microwave-assisted method is used to synthesize Cu nanostructure using polyvinylpyrrolidone (PVP) as a structure-directing agent and polyethylene glycol (PEG) as a reducing agent. The absorbance range of Cu nanostructure is observed between 300 and 400 nm. The energy bandgap rises when the concentration increases. While, the average crystallite diameter of each sample is obtained less than 50 nm.

1. Introduction

Research and development of innovative procedures for material preparation and fabrication have always played a significant role in the ongoing development of materials science. Researchers have been looking for a material synthesis technique with low production costs, simple operation, little pollution, and high product performance for a very long time [1,2]. Conventional techniques, such as hydrothermal and thermal treatments, are time/energy intensive or expensive. In comparison to these approaches, microwave-assisted hydrothermal synthesis is a simple, efficient, and adaptable process [3]. The hydrothermal technique aided by microwaves offers inherent consistency, better productivity, rapid volume heating, morphological controllability, and the capacity to manufacture high-purity nanoparticles with narrow size distribution in a shorter production period [4]. The integration of rapid microwave heating into a hydrothermal process has the potential to efficiently and affordably synthesise nanostructured transition metals by rapidly enhancing the crystallisation kinetics of the synthesis process [5]. The hydrothermal approach simulates the development of crystals during the formation of metal in nature by utilising water, acid or alcohol as a solvent in a closed system at a specific temperature and pressure [6]. The microwave hydrothermal method is a modern approach for creating powders. It heats materials using microwaves and the principles of hydrothermal methods. Unlike the traditional hydrothermal method, it blends microwave and solution heat benefits. It employs microwave heating, Unlike pure conduction in the hydrothermal method, different from single conduction method [7].

Copper (Cu) nanostructures have received considerable attention in recent years due to its fascinating qualities, which make it useful in electric and electronic field. According to previous studies, several research approaches have been established and implemented in order to enhance the optical and structural properties of Cu nanostructures [8,9]. In this study, hydrothermal microwave-assisted synthesis technique is one of the essential parts of this study. This approach uses a microwave oven to rapidly and uniformly heat the reaction system and employing PVP as a structure-directing agent and PEG as a reducing agent, hence accelerating reactions [10,11]. Moreover, PVP can act as a surface stabiliser, growth modulator, dispersion of nanoparticles, and reducing agent. It is a crucial reagent in the size and structural development of Cu nanostructure [12,13,14]. While, the PEG is utilised as a capping agent or reductant in the manufacture of Cu nanostructures. It aids in the control of the size, shape, and stability of the resultant nanostructures [15]. Therefore, it can be used to modify the morphology or structure of materials, so improving the optical and structural properties of

* Corresponding author.
E-mail address: akmalcl@ump.edu.my (N.A. Che Lah).

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