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Silver nitrate concentration on silver nanoparticles formation attached on cellulose nanocrystal matrix

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ABSTRACT

Cellulose nanocrystals (CNCs) with silver nanoparticle composites are used in various applications, ranging from packaging to biomedical. Therefore, the optimum performance of this hybrid nanomaterial can be achieved by controlling agglomeration in the silver nanoparticle synthesis. The agglomeration behaviour can be monitored by integrating CNCs as polymer matrix during the synthesis. This work aimed to investigate the effect of silver nanoparticles (AgNPs) synthesised from different silver precursor concentrations and loaded on the surface of CNCs. The cellulose nanocrystal was isolated from an oil palm empty fruit bunch (EFB). The AgNPs were synthesised by using the reduction technique of silver nitrate at 0.1 M and 0.5 M concentrations and with the aid of glucose solution. The AgNPs_CNC nanosuspension was analysed by using UV–Vis spectroscopy, FTIR, DSC, and FESEM/EDX. The spectroscopy data from UV–Vis indicated a strong absorption peak at 385 nm due to the formation of the nanoparticles in AgNPs_CNC_0.5 nanosuspension. Meanwhile, the morphological result showed that the AgNPs formed were spherical in shape (57.8 nm) with strong existence of silver, carbon, and oxygen. Therefore, the AgNPs_CNC nanosuspension was successfully synthesised by using 0.5 M silver nitrate with uniform and well-distributed nanoparticles.

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1. Introduction

Hybrid nanomaterial is a nano-scale combination of organic materials, such as carbon nanotubes [1] and nanocellulose, [2] with inorganic materials, e.g. metallic nanoparticles [3], to enhance the characteristics and functionalities for advanced applications. Amongst various types of metallic nanoparticle used, work related to silver nanoparticles (AgNPs) has become one of the most significant and attractive [4]. AgNPs are a common antimicrobial agent with distinct physicochemical properties [3,4]. Surface area, particle morphology, dissolution rate, agglomeration, and capping are only a few physicochemical properties of AgNPs that are critical when deciding about their interactions and impacts [5]. However, AgNPs will easily aggregate within their nanoparticles, resulting in restricted surface access and limited antimicrobial functions. Therefore, proper colloidal stabilisation, such as nanocellulose is essential to reduce the aggregation of AgNPs when dispersed in any liquid medium [6].

Cellulose nanocrystals (CNCs) have been widely developed due to their abundant resources and sustainable material [2]. It is a natural polymer that can be isolated through any available lignocellulosic materials, such as wood chips [7], corn stalks [8], rice straws and oil palm empty fruit bunches [9]. In addition, the isolation process through acid hydrolysis process [10] for CNC production has been proven, resulting in further investigation to enhance the functions of CNCs. High crystallinity, high surface area, non-toxicity, and biodegradability rate enhancement are just a few of the outstanding characteristics of CNCs [8]. Besides, CNCs provide excellent support for loading inorganic nanoparticles into an aqueous media by forming stable nano-hybrids [11].

In hybrid nanomaterial formation, the aggregation of silver nanoparticles is one of the main issues in the synthesis stage. To overcome this drawback, silver nanoparticles need to be incorporated into organic nanomaterials such as CNCs suspension to ensure that optimum performance is accomplished [12]. Cellulose

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