Research Article

Physicochemical properties of Kartina textile with Carrageenan filled with zinc oxide nanoparticles (ZnONps)

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Received: 7 November 2018 Revised: 10 December 2018 Accepted: 25 December 2018

Abstract

Objective: Nanotechnology is one of the greatest breakthroughs in the field of science and technology that have numerous applications that are essential, nowadays. This study was conducted to synthesize ZnONps from carrageenan and characterized the carrageenan with ZnONps using UV-VIS, SEM and FTIR. **Material and methods:** The Kappa Carrageenan was used to synthesize ZnONps using the wet chemical method. The synthesize ZnONps was characterized using Fourier Transform Infrared to identify the functional group present. UV-Vis was used to determine the wavelength spectra of the sample. The Scanning Electron Microscopy was used to determine the surface morphology of the sample. **Results and conclusion:** The colorless solution changes into milky white colloid mixture that indicates the presence of ZnONps. The wavelength peak using the UV-Vis was observed around 350-400 nm. Presence of Alkyne group was seen after the FTIR analysis and also, presence of white powdery substance-which indicates the presence of ZnONps- in textile, was seen after the SEM analysis.

Keyword: Nanotechnology, zinc oxide nanoparticles, physicochemical properties, Carrageenan

Introduction

The use of nanotechnology in the field of textiles has received much attention with the current broad interest in nanomaterials and nanotechnology. With the advent of Science and Technology, a new area has developed in the realm of textile finishing. Nanocoating the surface of textiles, clothing, and textiles for footwear is one approach to the production of highly active surfaces to have UV-blocking, antimicrobial and self-cleaning properties. Carrageenan is classified as a food additive and shows the potential use for a new drug delivery system providing more control over the release rate of drugs. Being a sulfated polysaccharide, carrageenan is biocompatible, biodegradable, nontoxic, and cheap and gel forming (Briones, 2004).

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With the growing public health awareness of the pathogenic effects, malodors and stain formations caused by microorganisms, there is an increasing need for antibacterial materials in many application areas like medical devices, health care, hygienic application, water purification systems, hospital, dental surgery equipment, textiles, food packaging, and storage (Shahidi et al., 2007).

The wide range of applications is possible as ZnO has key advantages. It is bio-safe, biocompatible and can be used for biomedical applications without coating. With these unique characteristics, ZnO could be one of the most important nanomaterial in future research and applications (Kathirvelu et al., 2008).

ZnONps exhibit attractive antibacterial properties due to increased specific surface area as the reduced particle size leading to enhanced particle surface reactivity. ZnO is a bio-safe material that possesses photo-oxidizing and photocatalysis impacts on chemical and biological species (Sirelkhatim, 2015).

DOI: https://doi.org/10.31024/apj.2018.3.6.4

The usage of acidic electrolyzed water in the production of carrageenan and gelatin hydrosols and hydrogels has not caused undesirable changes in their chemical and texture properties (Brychcy et al., 2015).

Materials and methods

Synthesis of Zinc Oxide nanoparticles

The preparation was done with the procedure of Rao (2015) with some modification made. Zinc Oxide nanoparticles (ZnONps) was prepared by using zinc nitrate and sodium hydroxides precursors and Kappa Carrageenan as stabilizing agent. About 0.1 g of Kappa Carrageenan was dissolved in 500 mL of lukewarm distilled water. About 14.84 g (0.1 mol) of zinc nitrate was added in the above solution, and it was followed by constant stirring for 1 hour, use a magnetic stirrer to completely dissolve the zinc nitrate. After complete dissolution of zinc nitrate, 0.2 mol of sodium hydroxide solution were added drop by drop under constant stirring. The reaction were allowed to proceed for 2 hr. After the completion of the reaction, the solution was kept overnight, and the supernatant solution were carefully discarded afterwards. Rest of the solution were centrifuged at 10 rpm for 10 min and the supernatant was discarded. Thus, the nanoparticles were obtained and it was washed thrice using distilled water. Washing was carried out to remove the by-products and the excessive starch bound with nanoparticles. After washing, the nanoparticles was dried at 80ºC overnight.

Coating of Textile with ZnONps

Zinc oxide nanoparticle was applied to a textile "Katrina" by a pad-dry-cure method. The textile was cut to a size of 30 by 30 cm, and it was immersed in a solution of 2% ZnONps for 5 minutes. After soaking, the textile was air dried and then cured for 3 minutes in the drying oven at 140°C The coated fabric was soak for 5 minutes in 2.0 g/L sodium lauryl sulphate to remove any unbound nanoparticles. Then, the fabric was rinsed 10 times to completely remove any traces of soap. The fabric was finally dried.

Characterization using Ultraviolet-Visible (UV-Vis) Spectroscopy

The Ultraviolet-Visible Spectroscopy was warmed up for 15 minutes. The wavelength was calibrated. The first cuvette was the distilled water and the other contained the ZnONps. The set of range of 350nm-550 nm was used in each concentration, the wavelength was calibrated before working for the next concentration to refresh the instrument. The absorbance was read every after 1 minute of placing the sample cuvette in the sample compartment.

Characterization using Fourier Transform Infrared (FTIR) Spectroscopy

FTIR Spectroscopy is widely used to study the surface adsorbents in nanoparticles. It is an effective tool for detecting the shape of nanometer sized particles and mainly used to identify the functional groups present in the sample.

Characterization using Scanning Electron Microscopy (SEM)

The conditioned samples was place in a Scanning Electron Microscope (SEM), the surface microstructure of sample textile was investigated with this machine. Magnifications from 2000 to 10000 µm was used.

Characterization of ZnONps

The ZnONps was placed in a Scanning Electron Miscroscope (SEM) the surface nanostructure of metal oxide nanoparticle was determined using this machine. Magnifications from 2000, 5000 and 10000 µm were used.

Results and discussion

Wavelength Spectra

Ultraviolet-Visible Spectroscopy is the first characterization of Zinc oxide nanoparticles (ZnONps). A typical ZnONps has a λmax value that is visible in 350-400 nm range. In this study, the absorption peak was identified between 350-400nm. This result clearly proves the successful reduction of ZnO^+ to ZnO and of the synthesis of ZnONps. The formation of ZnONps was observed to have increased as concentration increases.

According to the study of Subhankar and Deependra (2014), the peak of ZnONps was found at 370 nm which was the wavelength of ZnONps formation. The ZnONps shows that the absorption less than 400 nm. The result of ZnONps with Carrageenan on the figure 1 shows that the absorbance of Zinc oxide nanoparticles had a maximum peak less than 400nm. Nafchi (2012) suggested that samples incorporated with ZnONps could be used as UV-shielding films and heat because of its capacity absorb UV light.

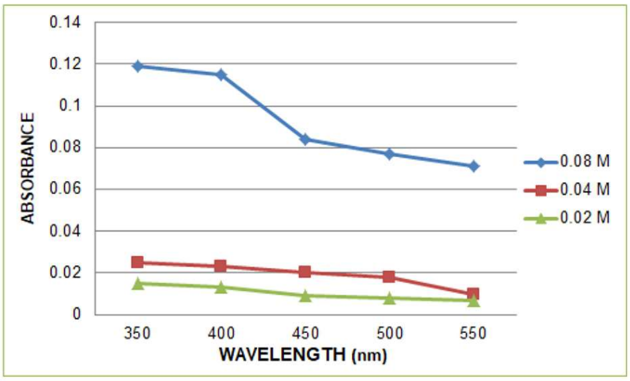

Figure 1. Wavelength spectra analysis

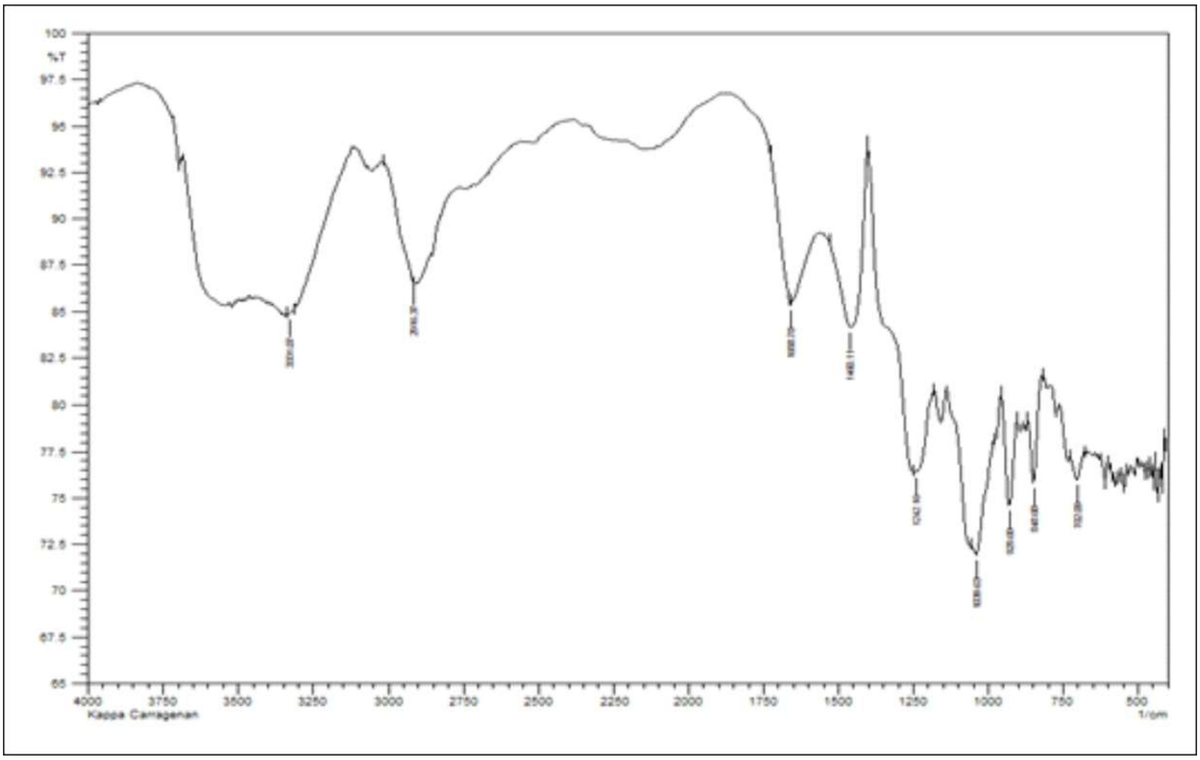

Figure 2. Functional group analysis

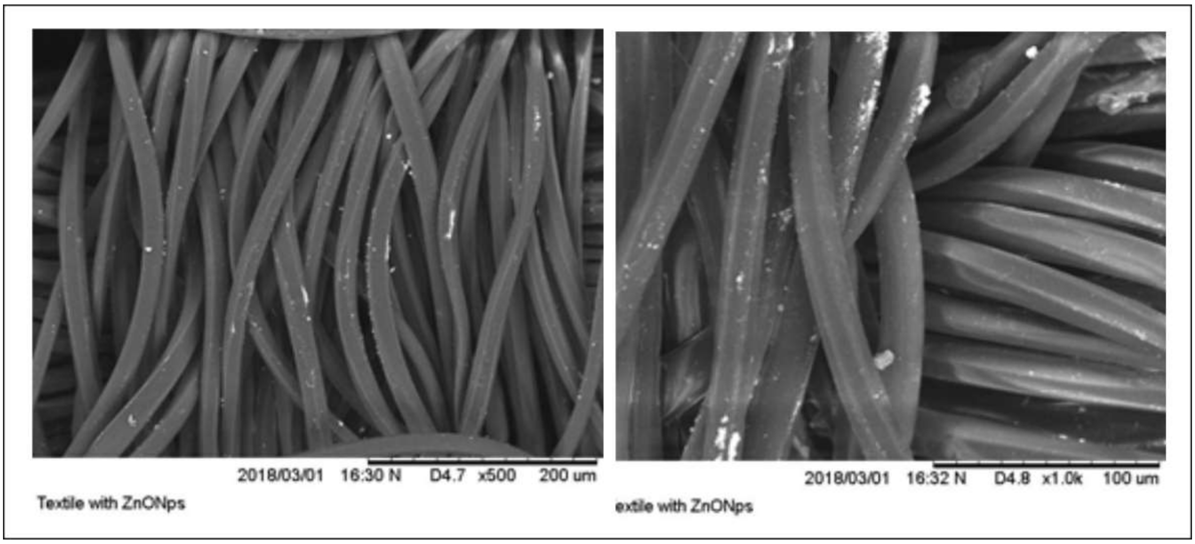

Figure 3. Surface Morphology of Textile with ZnONps

Functional group determination

The FTIR spectra of Carrageenan filled with Zinc oxide nanoparticles. The spectrum shows a significant peak at 3331.07 cm^{-1} which indicates the presence of Alkyne (≡C-H) group. There was no new functional group appeared after the application of ZnO, indicating that only physical interaction between the ZnONps and the textile matrix occurs cited by Nafchi (2012).

Surface morphology of textile

The SEM micrographs of treated textile coated with zinc oxide nanoparticles. It shows the textile with ZnONps, in powder white particles which it shows a good attachment of the ZnONps in the textile. Nano-sized ZnO suspension clearly has much higher activity than the micron-sized ZnO (Zhang et al., 2009).

Surface morphology of zinc oxide nanoparticles

Figure 4 shows the SEM micrographs of ZnONps at magnifications of 2000, 5000 and 10 000. Nano-sized ZnO suspension clearly has much higher activity than the micron-sized ZnO (Zhang et al., 2009)

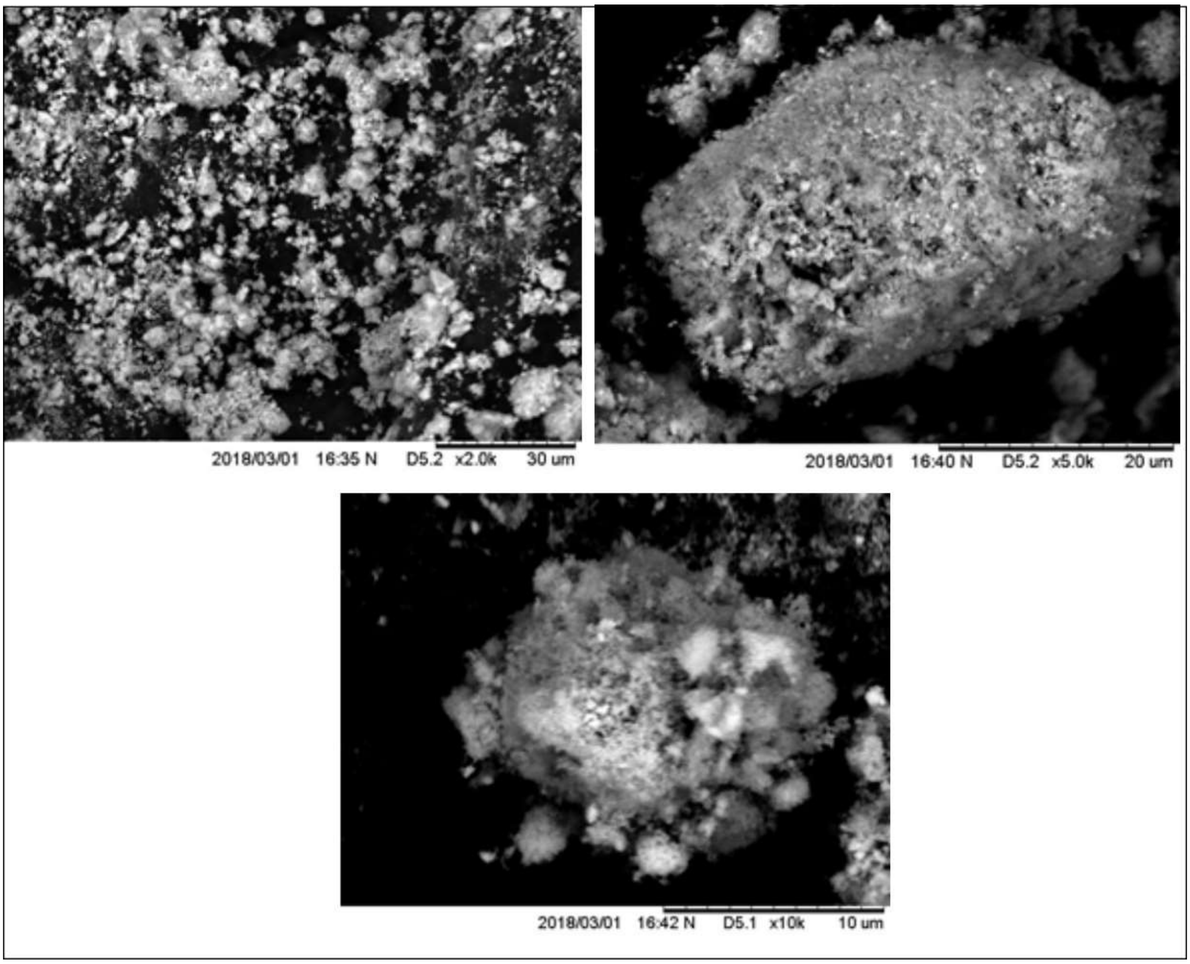

Figure 4. Surface Morphology of ZnONps with different magnifications

Conclusions

The characterization of zinc oxide nanoparticles was done using ultraviolet-visible spectroscopy, its absorbance peak between around 350-400 nm, and its surface morphology was determined using scanning electron microscopy (SEM) that the granules appeared in agglomerated state. Also, no new functional group was seen in the textile with zinc oxide nanoparticles. Thus, this research is a step forward for the textile industry.

Conflicts of interest: Not declared.

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