Available online at www.derpharmachemica.com

ISSN 0975-413X
CODEN (USA): PCHHAX

Der Pharma Chemica, 2016, 8(12):198-202
(http://derpharmachemica.com/archive.html)

Synthesis and Fluorescent Studies of Novel UV Functional Glass Fibers Coated with Composite of Chitosan-Nanophosphor

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ABSTRACT

The chitosan and organic Eu^{2+} nanophosphors based photochromic emulsion have been prepared by wet chemical method and coated on glass fiber by solvent evaporation technique. For this purpose, glass fibers were dipped in acetic acid solution; containing dissolved chitosan and Eu^{2+} nanophosphors. The coated fibers were characterized by FE-SEM, XRD, FT-IR and UV-PL. The coated fibers under UV irradiation showed broad-band absorption from 220-400nm wavelength; and quick photo-emissive response at 450nm wavelength, in pure blue region with high degree of reproducibility. The results indicate that, composite could endow glass fibers with excellent fluorescent properties. These glass fibers composite with remarkable photosensitivity found potential application as in smart and intelligent functional textiles.

Keywords: Chitosan; Composite; Functional Textile; Fluorescence, phosphors.

INTRODUCTION

In recent years, growing environmental consciousness has driven search for new textile functional materials. Especially smart and intelligent glass fibers emerged as a green approach in the field of textile research [1-4]. The previous literature reports, that researcher are engrossed with the fabrication of various fluorescent composites of glass. The glass fibers have ability to meet requisites for commercial applications [5-8]. It has fascinating transmission region in UV and IR bandwidth; better performance in stable photo-luminescent property, quantum efficiency, enhanced thermal stability and oxidative resistance [9, 10].

Chitosan obtained by the deacetylation of chitin is one of the most widely used biopolymer. It has been extensively studied due to its chemical stability, sustainability, availability, excellent metal chelating properties, and film forming ability [11, 12]. Chitosan has rich hydroxyl and amino groups throughout its polymeric chain, which play a significant role in organic-inorganic hybrids to incorporate and trap different metals and rare earth ions [13-15]. However, studies that link the optical performance of lanthanides in association with chitosan as composite rarely been reported.

This research is an attempt to prepare composite of fluorescent organic phosphors with natural polymer such as chitosan for functional materials coating on glass fibers.

MATERIALS AND METHODS

2.1 Materials and Preparation of Chitosan/ Phosphors composite and coating on glass fabric

All starting materials of AR grade were obtained from commercial suppliers and used in received form without further purification. Glass fibers were supplied by Montex glass fiber India Pvt. Ltd. India. The inorganic phosphors doped with Eu^{2+} ion prepared by wet chemical method, the requisite amount of ingredients chitosan and $BaMgAl_{10}O_{17}:Eu^{2+}$ were calculated on the basis of stoichiometric chemistry to get maximum quantum yield (Φ). [16], the phosphor compound obtained in smooth, bulky nano-rods which are fairly dissolved in chitosan in dilute acetic acid and magnetically stirred for 30 hr at room temperature produce transparent emulsion.

Glass fibers then dipped in emulsion for about 30 minute then dried in ambient air for about 24 hr. for solvent evaporation. A thin uniform transparent coating of composite on glass fiber was deposited without altering fabric structure.

2.2 Characterizations

Particle morphology of initially prepared $BaMgAl_{10}O_{17}:Eu^{2+}$ nano-phosphors and chitosan phosphor composite coated glass fibers were examined by FE-SEM (S 4800 Hitachi Model Type 2), and shown in Figure 1. powder phosphor particle have slightly elongated and fairly been deposited on fiber (Fig.1d.) The X-ray diffraction patterns of pure chitosan and chitosan composite shown in Figure 2.which depicts the emulsion of dispered particles pattern.

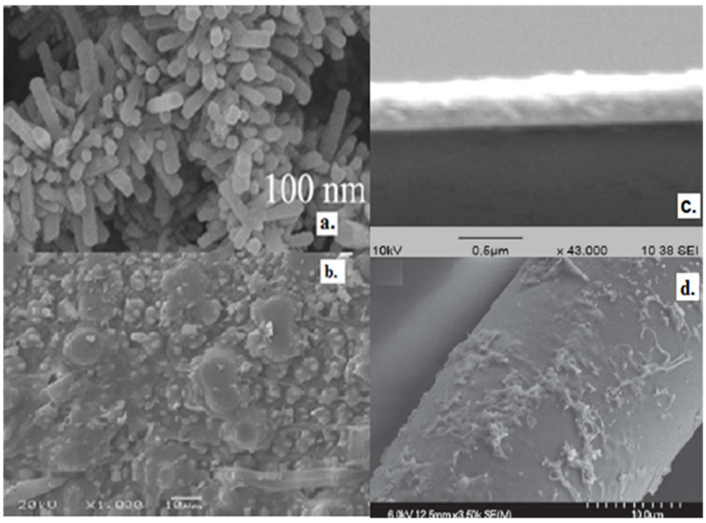

Figure1. SEM micrographs of (a) Eu^{2+} nanophosphors (powder form) (b) Chitosan, (c) Coated glass fiber cross section and (d) Coated glass fiber surface morphology

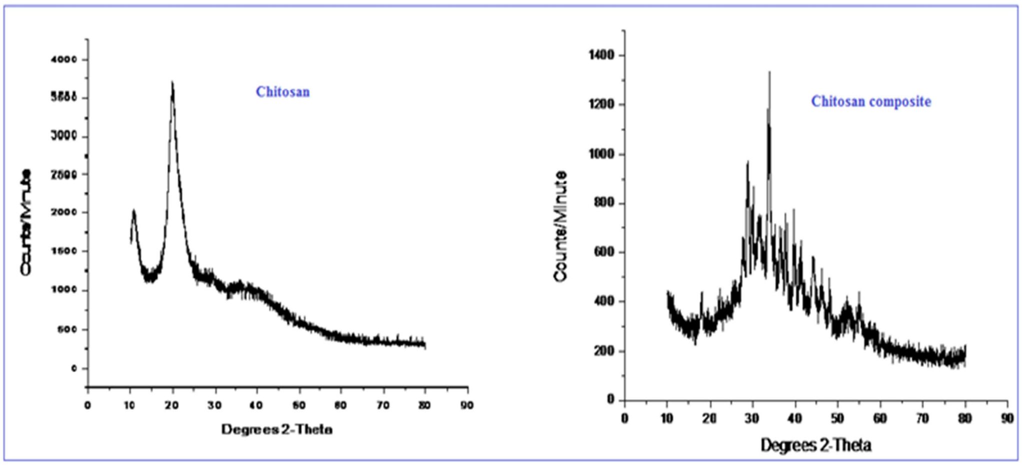

Figure 2. X-ray diffraction (XRD) patterns of the pure and chitosan composite

FT-IR spectra of samples chitosan and chitosan composite were performed by KBr disk method with a Nicolet-5700 Fourier transform infrared spectrometer USA in the wavenumber 500-4000 cm^{-1} shown in Figure 3.

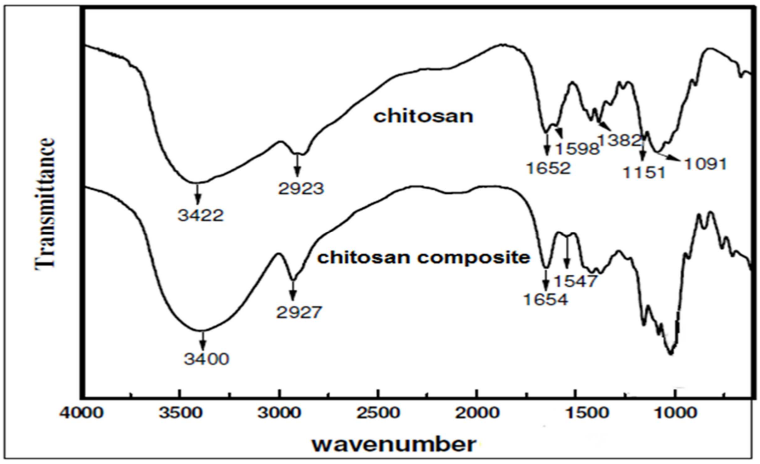

Figure 3. FT-IR Spectra of pure chitosan and chitosan composite

The fluorescent emission spectra was obtained by exciting raw powder nanophosphors and composite coated glass fibers using UV radiation at room temperature (Hitachi F- 7000 spectoflurometer) in the range of 220- 400 nm. The excitation and emission spectra recorded shown in Figure 4.

Fluorescent properties are the characteristics of rare earth (RE) Eu2+ ion, the heavy RE ion trapped in the polymeric chain of chitosan by hydroxyl and amino groups shown in figure 5.This stable structure is a excellent host for RE centre ion and responsible for fluorescent properties.

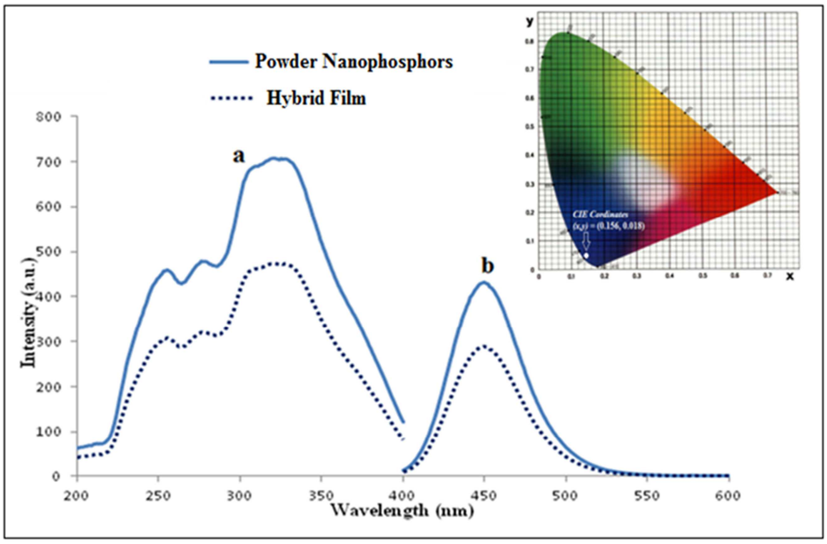

Figure 4. Fluorescence Spectra (a) Excitation and (b) Emission, of powder $BaMgAl_{10}O_{17}:Eu^{2+}$ nanophosphors and coated glass fiber. Inset CIE coordinates of Emission wavelength

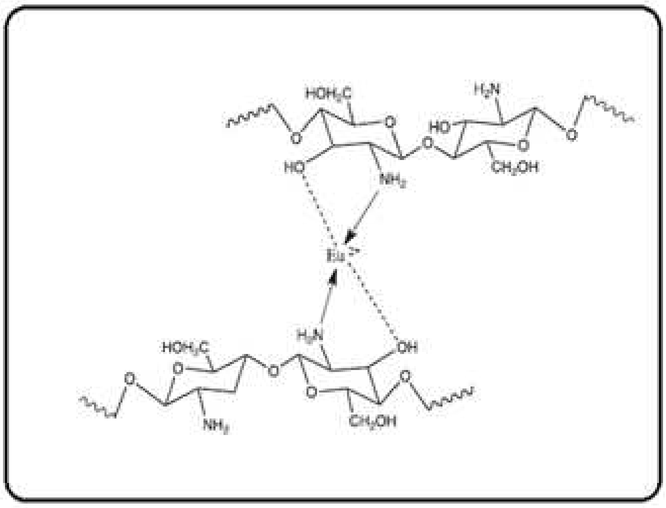

Figure 5. Trapped Eu^{2+} ion in polymeric chain of chitosan

RESULTS AND DISCUSSION

UV spectrophotometry is a useful approach for investigating the nature of luminescent materials. Inorganic phosphors containing a rare earth ion as an activation center are well known for color emission [17]. The prepared Eu^{2+} doped phosphor(powder form) and chitosan-phosphor based composite, deposited on glass fibers are examine for optical investigation, excitation monitored at λ_{max}= 450 nm shows double hump broadband from 220 to 400 nm peaking at 254 and 330 nm which corresponds to significant charge transfer band in powder and composite. Figure 4 a and b. showed that the peak intensity is slightly decreased for composite. However the emission peaks have the same position for the hybrid as in nanophosphors with the broad emission peaking at deep blue color region around 450 nm.

CONCLUSION

In summary, this study demonstrates a simple, reliable and successful method for the fabrication of organic-inorganic hybrid framework on glass fiber surface. The chitosan in composite played a major role as binder and adhesive for metal ions by producing transparent thin composite coating without interfering in emission. Pure blue color emission of composite widens the scope for UV sensitive glass fibers in smart and intelligent functional textiles.

Acknowledgements
We gratefully acknowledge the management of VIT University for providing required facilities.

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