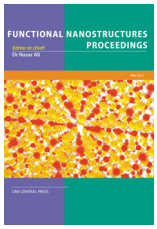
ONECENTRAL PRESS

Available online at www.onecentralpress.com

One Central Press

OPEN ACCESS

proceedings webpage: www.onecentralpress.com/functional-nanostructures-proceedings



Biodegradable PHBHHx Fibers Reinforced with Capped ZnSe QDs for Photocatalysis

Sharmila Lydia I[a], Thilak Moses A[b], Radhika N[a], Steplin Paul Selvin S[a]*

[a]*Department of Chemistry, Bishop Heber College,Tirucppalli, India.*
[b]*Department of Mathematics, Bishop Heber College,Tirucppalli, India.*
**corresponding author*

ABSTRACT

Poly 3-hydroxy butyrate–co-3-hydroxyhexanote (PHBHHx) based biodegradable fibers reinforced with capped ZnSe QDs, were successfully prepared via electrospinning method. ZnSe quantum Dots (QDs) with a cubic zinc blende structure of 13 nm evidenced by XRD, were anchored in the PHBHHx copolymer matrix. The netted like morphology of electrospun PHBHHx fibres and the smooth distribution of ZnSe QDs in the electrospun fibers were confirmed by SEM characterization and the elemental analysis also proved the presence of ZnSe QDs without any other impurity peaks on the copolymer matrix. On the whole, the results demonstrated that the incorporation of ZnSe QDs on to the PHBHHx polymeric matrix has a positive effect on the photocatalytic degradation of azo dye, which could be a potential alternative to visible light active photocatalysis.

I. INTRODUCTION

Water effluents generated by the dye and textile industries have serious environmental concerns because they contain significant amounts of azo dyes and their degradation products such as aromatic amines which are highly hazardous and toxic. Conventional treatment methods are unsatisfactory and therefore advanced oxidation processes such as photocatalytic methods [1] have been developed for water treatment. Poly 3-hydroxy butyrate–co-3-hydroxyhexanote (PHBHHx) is a bio-based polymeric material that is naturally synthesized by various microorganisms. The main aim of the present study is to prepare biodegradable PHBHHx-based fibres reinforced with LCZS QDs suitable for visible light active photocatalysis.

II. EXPERIMENTAL

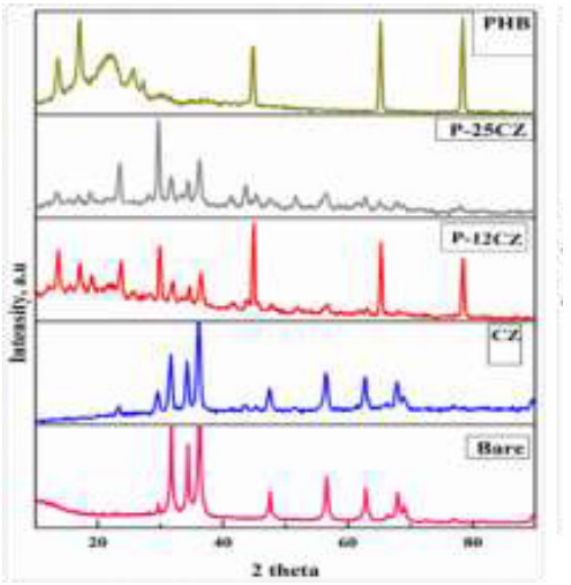
Fabrication of PHBHHx- ZnSe **electrospun fibre film**
Heavy metals-free L-cysteine capped QDs were synthesized according to the literature [2]. PHBHHx12LCZS and PHBHHx25LCZS precursor solutions were prepared by dissolving 12 g and 25 g of LCZS QD's respectively in 100 ml of 12%(w/v) PHBHHx solution followed by electrospining process.

III. RESULTS AND DISCUSSION: CHARACTERIZATION

PHBHHx shows a strong absorption at λ_{max} 213 nm in the ultraviolet region, which is characteristic of the polymeric material. However, the absorption gradually extends from ultraviolet region to visible region (400-430 nm) and grows in intensity as the concentration of ZnSe QDs increased and the optical band gap 'E_g' was calculated as ZnSe (3.3eV), PHBHHx12LCZS (3.2eV) and PHBHHx25LCZS (3.06 eV).

The structure and crystallinity of the obtained ZnSe, LCZS, PHBHHx, PHBHHx12LCZS and PHBHHx25LCZS were demonstrated by the XRD patterns as presented in Figure 1. The four peaks at 27.2, 45.3, 53.6, and 65.2 could be indexed to the typical (111), (220), (311), (400) and (331) crystal plane of pure cubic ZnSe phase (JCPDS Card 65 – 9603). The actual crystallite size of ZnSe is about 11 nm according to Scherer's equation. The diffractogram of PHBHHx shows main peaks at 2θ values of 10.1°, 13.6°, 17.1°, 20.3° and 21.7° which correspond

to the reflection of the (020), (110), (021), (101) and (111) crystalline phases [3]. The characteristic peaks of ZnSe show that the presence of Zn, Se and S in the ratio 1:0.1:0.04 thus confirming the existence and composition of these elements. The EDX analysis of PHBHHx25LCZS indicates that the sample is composed of the elements Zn, Se, S and carbon with no other impurity peaks.



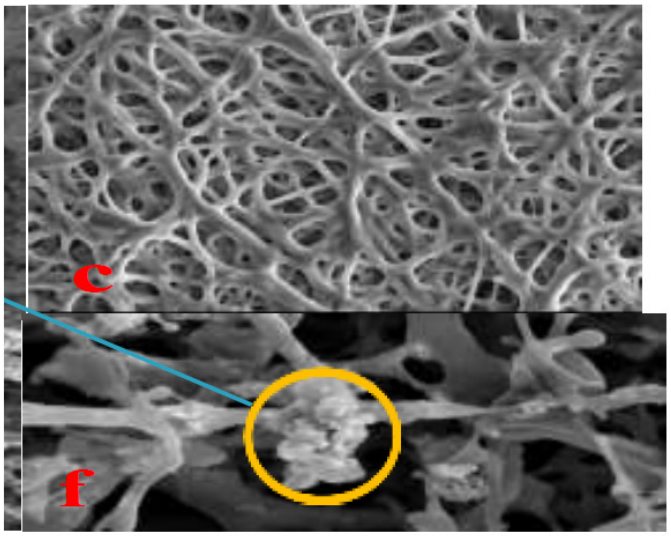


Figure 1 Powder XRD patterns of Neat ZS, LCZS, PHBHHx, PHBHHx12LCZS and PHBHHx25LCZS.
Figure 2 SEM images of PurePHBHHx, PHBHHx, 25LCZS.

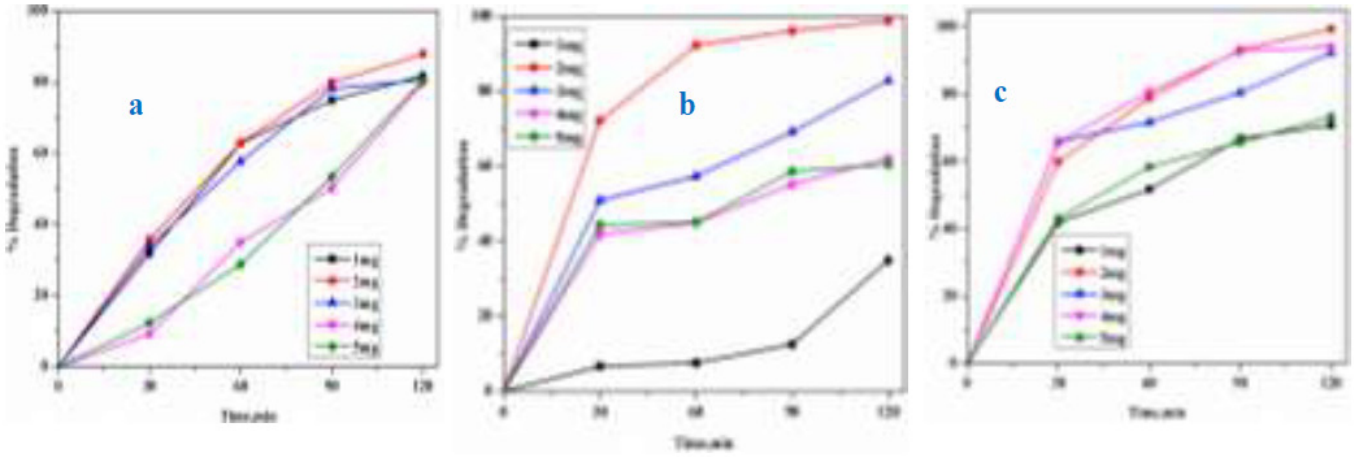


Figure 3 The degradation of AZ dye solution using (a) PHBHHx, (b) PHBHHx12LCZS and (c) PHBHHx25LCZS.

Photocatalytic degradation of AZ: In the absence of the photocatalyst, the AZ dye solution could not be degraded successfully and only 12.06 % colour removal was achieved after 150 min of sunlight irradiation (Figure 2). Meanwhile bare ZnSe showed 26.01 % decolourisation and the decolourisation reached 63.8 % with cysteine-doped ZnSe QDs after 150 min of irradiation. The degradation efficiency of PHBHHx12LCZS and PHBHHx25LCZS were 98.96 % and 99.7% respectively. A plot of lnC0/C vs. time shows a linear relationship which suggests a pseudo first order reaction with the rate constants 0.0174, 0.0364 and 0.0402 min^{-1}. The decolourisation efficiency of the electrospun PHBHHxLCZS exhibited a gradual decrease from the 5^{th} usage onwards reaching only 60.8 % at seventh repeated usage. The presence of heterojunction favours the separation of electron-hole pairs.

IV. CONCLUSION

The L-cysteine capped ZnSe QDs reinforced with PHBHHx fibres obtained by electrospinning method were used as a visible light active photocatalyst for the degradation of AZ dye under solar light irradiation. The results confirmed that the incorporation of polymer matrix is a novel support for the degradation of dye and textile dye industry waste waters.

V. REFERENCES

[1] M. M. Alnuaimi, M. A. Rauf, S. S. Ashraf, Dyes and Pigments, 72 (2007), 367.

[2] Y. L. Ding, J. X. Bi, J. Du, X. Y. Hu, F. T. Liu, Materials Research Innovations, 17 (2013), 142.

[3] J. S. Choi, S. W. Lee, L. Jeong, S. Bae, B. Min, J. H. Youk, Int J Biol Macromol, 34 (2004), 249.