Issue 48, 2020

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From the journal:
Dalton Transactions

Facile synthesis of a novel nitrogen-doped carbon dot adorned zinc oxide composite for photodegradation of methylene blue †

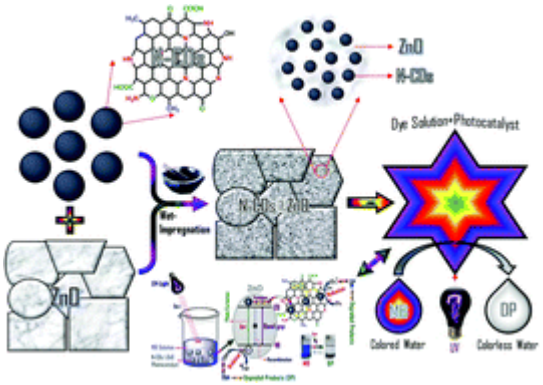
Raji Atchudan, ‡*[a] Thomas Nesakumar Jebakumar Immanuel Edison, ‡[a] Shanmugam Mani, ‡[c] Suguna Perumal, ‡[ab] Rajangam Vinodh, ‡[d] Somanathan Thirunavukkarasu ‡[e] and Yong Rok Lee *[a]

Author affiliations

Abstract

Nitrogen-doped carbon dot decorated zinc oxide nanoparticles (N-CDs@ZnO composite) were successfully fabricated by an economical wet-impregnation method and used as a photocatalyst for the degradation of

aqueous methylene blue (MB) dye under UV-light at room temperature. The chemical composition and morphological features of the prepared N-CDs@ZnO composite were characterized by attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy, X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), and field emission scanning electron microscopy (FESEM). The photodegradation capability of the N-CDs@ZnO composite was compared with that of bare ZnO nanoparticles, under identical experimental conditions. The results show that the N-CDs@ZnO composite exhibits notably higher photocatalytic activity (degradation efficiency over 99%, 60 min) compared to bare ZnO nanoparticles (75%, 60 min) towards the degradation of MB under UV-light irradiation. Besides, the degradation obeyed the pseudo-first-order kinetics model with a photocatalytic rate constant (k) of 0.0557 min^{-1}, which was ~2.3 times higher than that of bare ZnO nanoparticles (0.0240 min^{-1}). The crucial roles of N-CDs in the enhancement of the photocatalytic activity of the N-CDs@ZnO composite arise because the N-CDs can efficiently absorb UV-light and trap electrons, thus hindering the recombination of the photo-generated electron–hole pairs and also suppressing the photocorrosion of the ZnO nanoparticles in the N-CDs@ZnO composite. The N-CDs@ZnO composite not only showed good photocatalytic activity but also had good stability since the photocatalytic activity did not significantly decrease after three cycling tests. The present study shows that the N-CDs@ZnO composite can be considered as an ideal photocatalyst in the field of dye degradation. Overall, the present approach obeys green chemistry principles with the simple construction of the N-CDs@ZnO composite and the composite holds promise for the development of efficient photocatalytic systems.



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Article information

https://doi.org/10.1039/D0DT02756A

Article type
Paper

Submitted
10 Aug 2020

Accepted
13 Nov 2020

First published
16 Nov 2020

Citation
Dalton Trans., 2020, **49**, 17725-17736

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