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Nanocubes phase adaptation of In_2O_3 implanted TiO_2 photocatalyst for dye degradation and tracing of adsorbed species during photo-oxidation of ethanol

In2O3注入的TiO2光催化劑的納米立方相適應性用於乙醇光氧化過程中的染料降解和吸附物種的示踪

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Abstract

This work remarks on the phase transition of In_2O_3/TiO_2 nanocubes from In_2O_3 nanorods with TiO_2 nanoparticles for the photooxidation of ethanol and its effective degradation (98%) of the malachite green (MG) dye using UV-vis light source. The as-prepared nanocomposites were composed of In_2O_3 nanorods and nanocubes with TiO_2 nanoparticles through the thermal treatment in reflux conditions followed at 500 ^oC. Besides, the photocatalytic reaction mechanism was explored by the DRIFT by observing the gas-phase ethanol oxidation in nanocubes transformation. This reveals the adsorption of ethanol molecules on the catalyst surfaces and converts into the H_2O and CO_2, which confirms the active photooxidation in the gas phase. The nanocubes combined with 2 wt% of TiO_2 nanoparticles act as an effective material for the promotion of the visible light absorption with the fast degradation of organic pollutant within 90 min.

Results and discussion

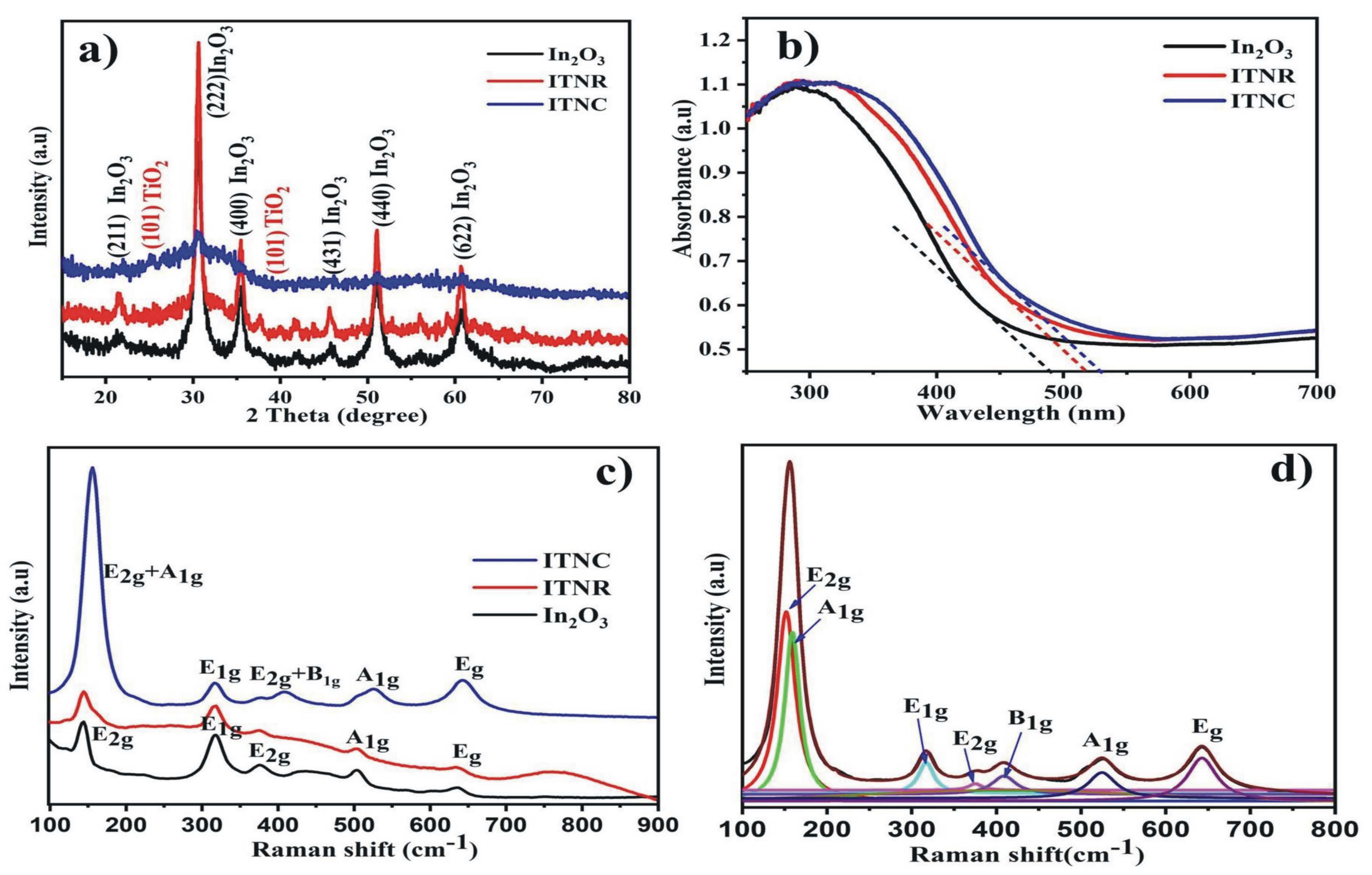

Fig. 1a) XRD pattern (b) UV-vis (DRS) (c) Raman spectra of In_2O_3, ITNR, and ITNC, (c) deconvoluted spectra of Raman for ITNC.

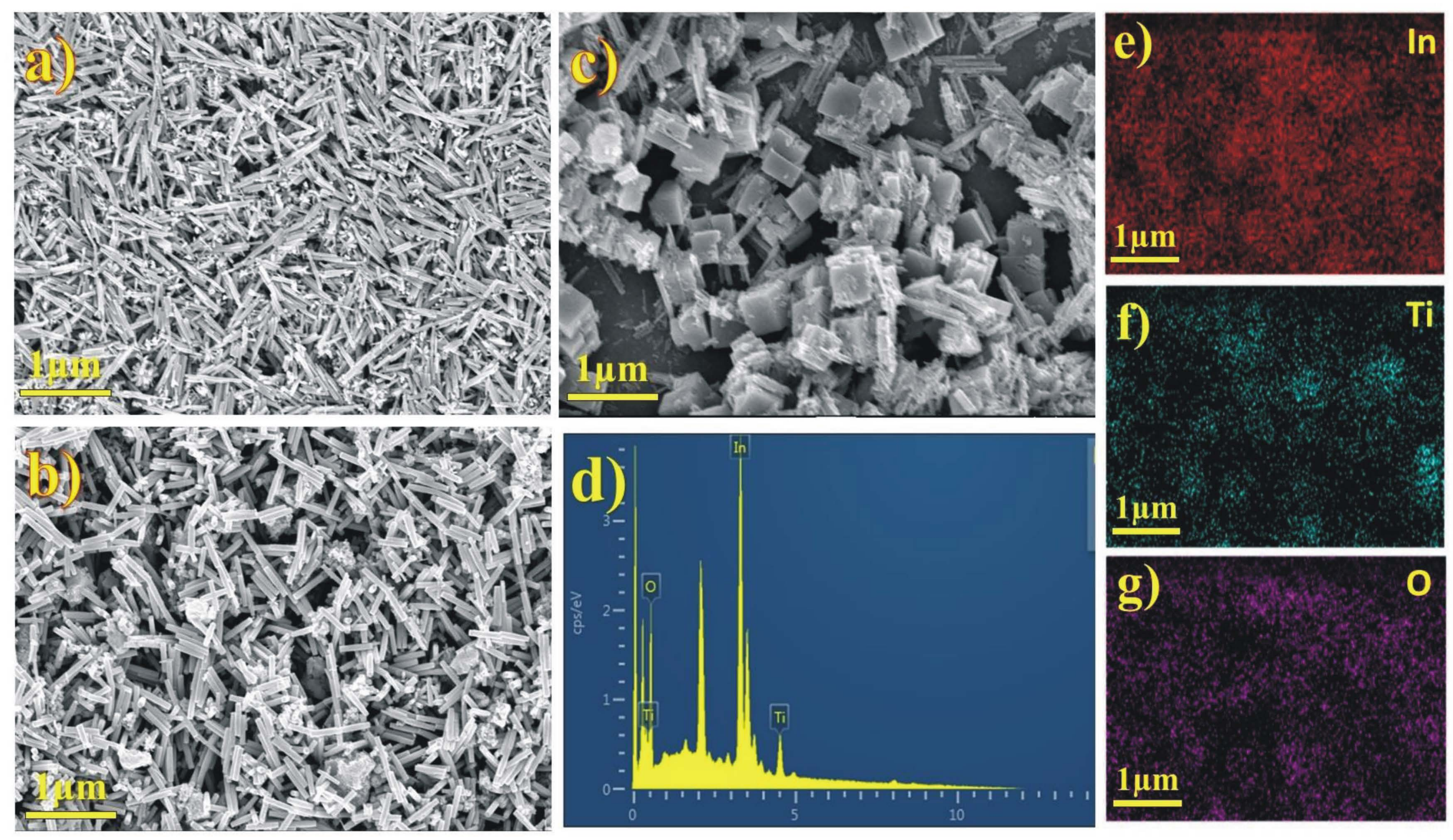

Fig. 2. FESEM image of In_2O_3, ITNR, and ITNC, corresponding EDX and mapping.

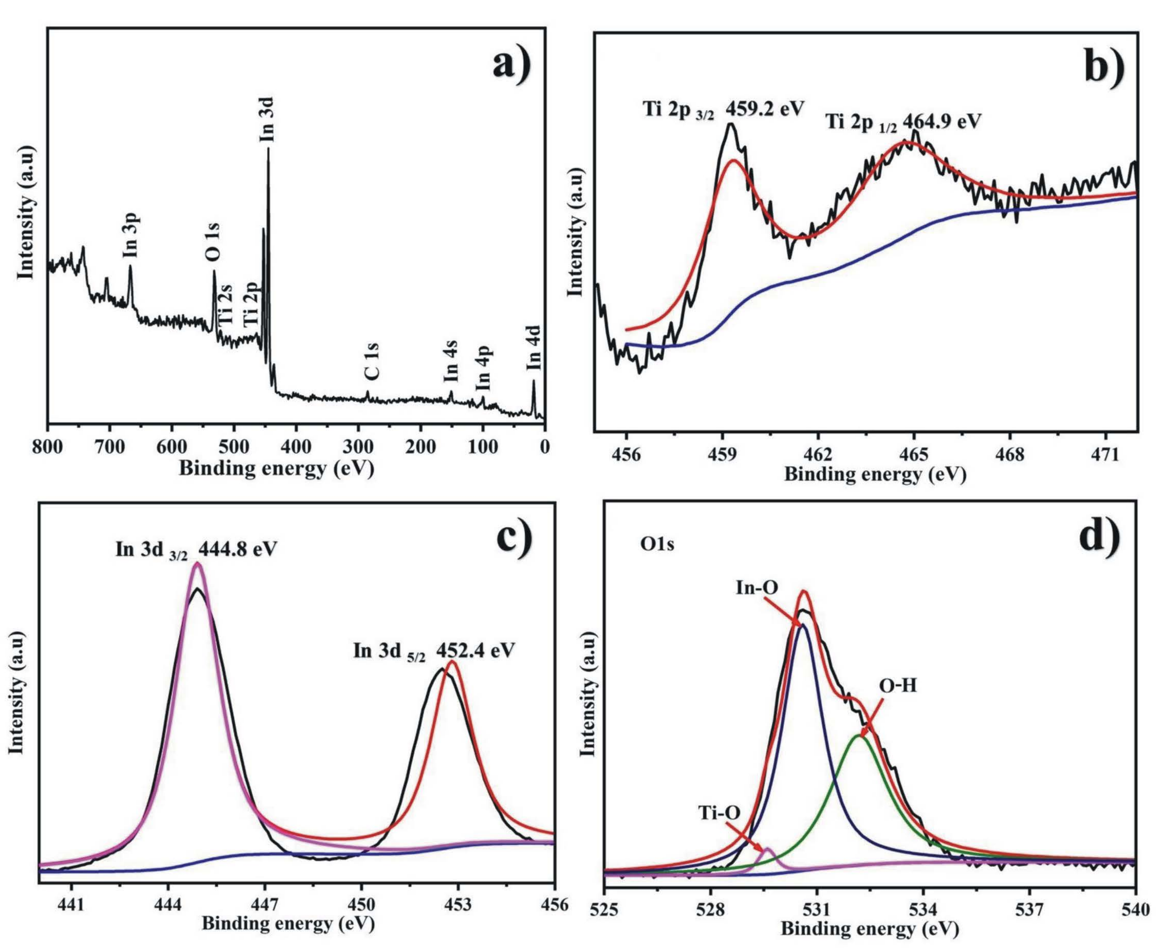

Fig. 3. (a) XPS survey spectra of ITNC, (b) Ti 2p (c) In 3d (d) O1s peaks.

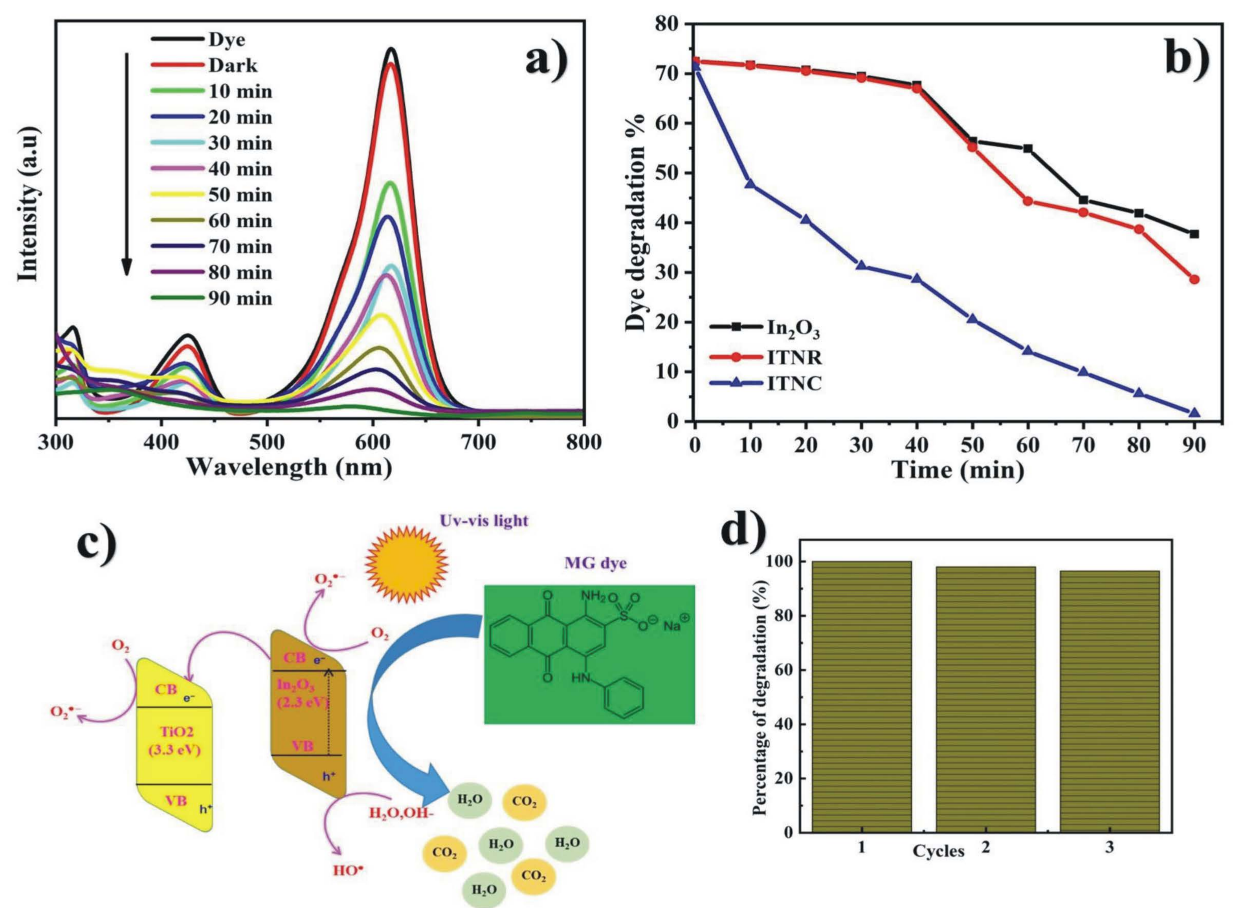

Fig. 4 (a) Represents the degradation of MG dye, (b) comparison studies of photocatalytic degradation of In2O3, ITNR, and ITNC, (c) Schematic diagram of the degradation of the mechanism of MG dye using the ITNC catalyst and d)Catalytic stability of ITNC.

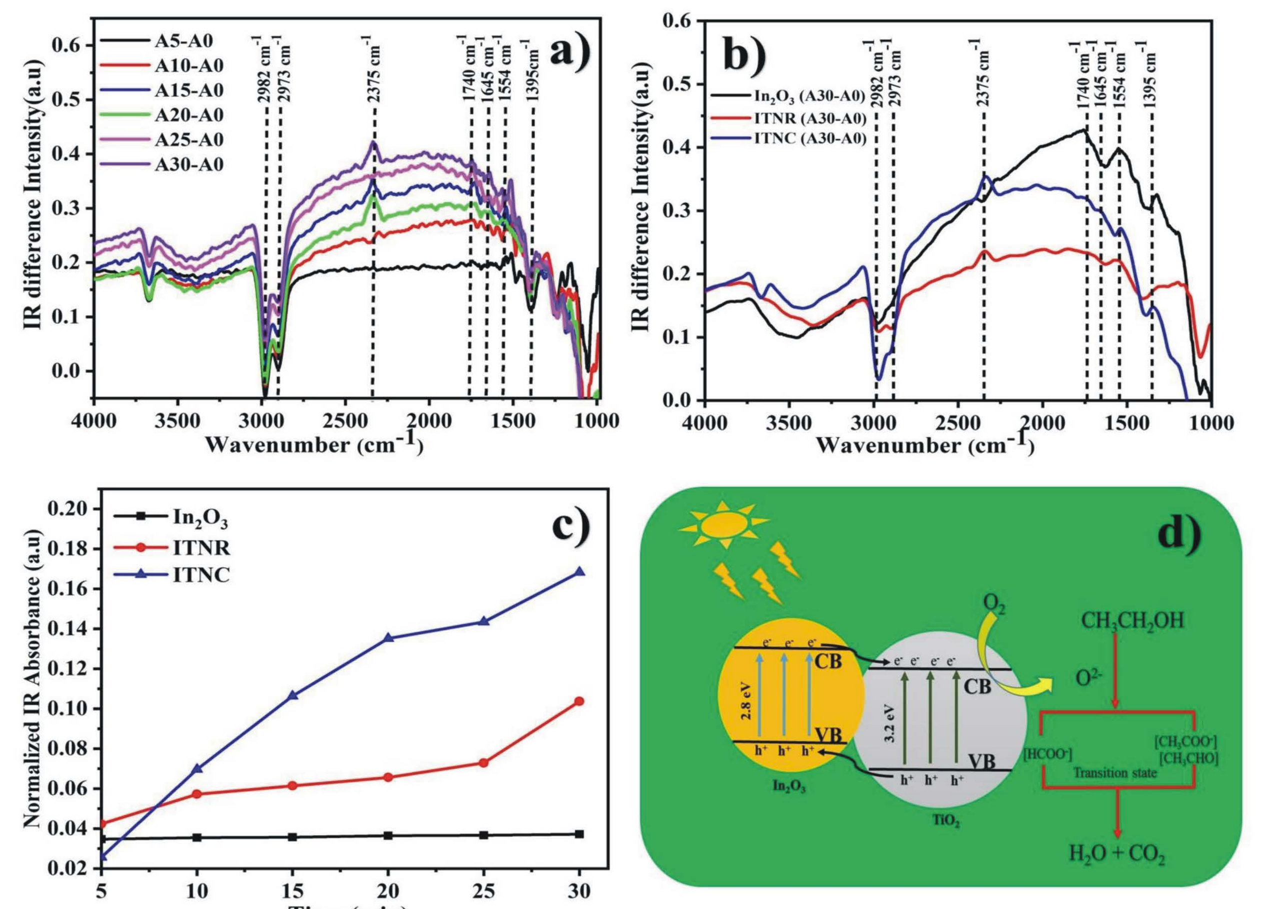

Fig. 5 (a) DRIFT spectra of ITNC, with different light irradiation time (5, 10, 15, 20, 25 and 30 min) after ethanol adsorption on the surface of catalyst in an oxygen atmosphere, (b) photocatalytic oxidation of ethanol using In_2O_3, ITNR, and ITNC catalysts, (c) rate comparison studies of CO_2 formation in presence of UV-vis light with different time intervals (5, 10, 15, 20, 25 and 30 min), (d) mechanistic diagram of photo oxidation of EtOH.

Conclusion

Prompt degradation of MG dye was noticed for ITNC (2 wt% TiO_2) composites when compared with In_2O_3 and ITNR (1 wt % TiO_2). The degradation efficiency of the ITNC composite was much higher than In_2O_3 nanorods and ITNR composite. The electron recombination rate was reduced much for ITNC catalyst which is confirmed with the PL study. The photo-oxidation of ethanol implies the evaluation of CO_2 and H_2O which specify the mechanism of the degradation process as similar with the DRIFT mechanism.

Authors Research information

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