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**Oxygen vacancies and phosphorus codoped black titania coated Carbon  
nanotube composite photocatalyst with efficient photocatalytic performance for  
the degradation of acetaminophen under visible light irradiation**

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Abstract

In the past two decades, carbon-titania composite photocatalysts had attracted extensive attention for high photocatalytic performance. However, their visible light driven activity was still limited. Therefore, it was urgent to find a way to improve its visible light responsive photocatalytic activity. In the present work, a novel efficient visible light driven photocatalysts, oxygen vacancies and phosphorus (P) codoped titania coated carbon nanotube composites (OVPTCN), were prepared by a facile two step solvothermal and phosphorization method for the first time. The obtained sample exhibited significantly enhanced photocatalytic performance for acetaminophen (ACE) degradation under visible light irradiation. The effects of carbon nanotube (CNT) amount and phosphorization content on the photocatalytic efficiency for ACE degradation were also investigated deeply. Results showed that the optimal sample exhibited a high rate constant of  $0.025 \text{ min}^{-1}$  for ACE degradation in contrast to that of pure  $\text{TiO}_2$  ( $0.00053 \text{ min}^{-1}$ ) and titania-carbon nanotube (TCN) composite ( $0.0036 \text{ min}^{-1}$ ). The characterization results suggested that phosphorization could produce

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