Modified photocatalyst effective for transforming organic pollutants into harmless end products

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UiTM researchers have developed a modified photocatalyst which is economical and effective at transforming organic pollutants into harmless end products.

Photocatalytic degradation is one of the highly effective applications in transforming organic pollutants to harmless end products at ambient conditions using light and a photocatalyst.

Titanium dioxide (TiO_2) is the most commonly used photocatalyst in many environmental applications but it can be used only under UV light owing to its high band gap energy (3.2 eV). UV light being energy intensive, it makes the photocatalytic degradation process very expensive.

In solar light spectrum, UV light exists only within 3-5% compared to visible light (45%). Therefore, for practical application, it is highly desirable to develop TiO_2 photocatalyst which can effectively degrade the pollutants under visible light irradiation.

Various techniques proposed in the literature to extend the absorption wavelength from UV to visible light region include semiconductor coupling, metal doping, dye sensitising and doping with nonmetal elements.

The most feasible method to modify the structure of photocatalyst is by doping with nonmetal, since it narrows down the band gap besides being stable, inexpensive and non photo corrosive. Doping with nitrogen attracted huge attention due to its high visible light active photocatalytic efficiency. Other nonmetal elements commonly used as dopants include iodine, carbon, sulphur and boron.

Nitrogen (N) and carbon (C) were selected as dopants in this study because they both could prevent the electron-hole pair from recombination during the photodegradation (how).

Researchers developed a modified photocatalyst which has desirable properties such as economical, environmental friendly, structural stability and high degradation rate by a simple preparation method after carefully studying the effects of dopant concentration and calcination temperature (advantages).

Application of this catalyst will ensure higher degradation rate of volatile organic compounds (carcinogenic) at lower cost leading to pollution free environment (socio economy impact).

This material will be of great help to the Petrochemical, Oil and gas industries to implement a low cost technology for the removal of organic pollutants at their premises (commercialisation potential). Elemental doping of titanium dioxide with nitrogen and carbon was investigated in this study to get the modified photocatalyst working under visible light.

Doped and codoped photocatalyst samples were synthesized by solgel method using titanium isopropoxide, ammonium nitrate and acetylacetone as precursors with the dopant concentration and calcination temperature fixed at 0.75% and 600oC respectively.

Synthesized photocatalysts were characterized by XRD, FTIR and

FESEM which supported the existence of anatase phase, presence of dopants and formation of fine particles respectively.

Theoretically photocatalytic activity is affected by many factors such as phase structure, crystallinity, surface hydroxyl density and oxygen vacancies. The highest photocatalytic activity was observed for N-C-TiO2. In 3 hours, the degradation was 91.3%.

This might be attributed to combined effect of the phase structure, particle size and the component existed in the photocatalyst. Strong anatase peaks as observed in XRD represented strong interaction of all the doped elements with TiO2 surfaces, which resulted in higher photocatalytic degradation.

Particle size also facilitated the photocatalytic reaction. Finer the size, higher is the photocatalytic performance which was well supported by the results from FESEM. The hydroxyl group presented in the photocatalyst as discussed in FTIR also contributed to the increased photocatalytic activity.

This novel material finds a solution to replace the use of high energy intensive UV radiation for the treatment of gaseous and aqueous pollutants with just with the ordinary domestic lamps to convert them into harmless end products (ecofriendly) thereby greatly reducing the total cost of waste management (economical).

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